KIKUSUI

PART NO. Z1-004-772, IB020522
Dec. 2010

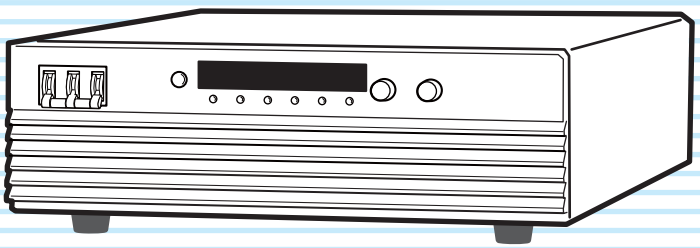
User's Manual

Regulated DC Power Supply

PAT-T Series

8 kW type

PAT20-400T
PAT30-266T
PAT40-200T
PAT60-133T
PAT80-100T
PAT160-50T
PAT250-32T
PAT350-22.8T
PAT500-16T
PAT650-12.3T
PAT850-9.4T



Installation and Preparation 1
Connecting the Load 2
Basic Operation 3
External Control 4
Parallel/Series Operation 5
Remote Control 6
Maintenance 7
Specifications 8
Appx

Thank you for purchasing the PAT-T Series Regulated DC Power Supply.

About Operation Manual

The operation manual for the PAT-T Series is consisting of the “User’s Manual” (this manual) and the “Communication Interface Manual”.

This manual is intended for users of the product or persons teaching other users on how to operate the product.

The manual assumes that the reader has knowledge about Power Supply.

- User’s manual (this manual)
  The User’s manual is intended for first-time users of this product. It provides an overview of the product and notes on usage. It also explains how to configure the product, operate the product, perform maintenance on the product, and so on. Read this manual thoroughly to use the functions of the product effectively.
  This manual is designed to be read from beginning to end. We recommend that you read it thoroughly before using this product for the first time.
  You can also review this manual when you are confused about an operation or when a problem occurs.

- The communication interface manual
  The communication interface manual describes the content of the commands.
  The interface manual is written for readers with sufficient basic knowledge of how to control instruments using a personal computer.
  The interface manual is provided in HTML format on the accompanied CD-ROM (a portion of the manual is in PDF format). You can view the Operating environment Windows 98 or later. You can view it using Microsoft Internet Explorer 5.5 or later. You can view the PDF file using Adobe Reader 6.0 or later.

If you find any incorrectly arranged or missing pages in the manual, they will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the “Kikusui Part No.” given on the cover.

The Operation Manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

After reading, always keep the manual nearby so that you may refer to it as needed.

Applicable firmware version of the PAT-T Series

This manual applies to PAT-T Series with firmware version 5.0x.

When making an inquiry about the product, please provide us with the following information.

- Model (indicated at the top section on the front panel)
- Firmware version (See page 1-6 .)
- Serial number (indicated at the bottom section on the rear panel)

This product information can also be obtained using the *IDN? remote control command.

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Safety Symbols

For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Note the meaning of each of the symbols to ensure safe use of the product. (Not all symbols may be used.)

or

Indicates that a high voltage (over 1000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.

DANGER

Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.

Shows that the act indicated is prohibited.

Indicates a general danger, warning, or caution. When this symbol is marked on the product, see the relevant sections in this manual.

Indicates a caution for hot surface of the product. When this symbol is marked on the product, see the relevant sections in this manual.

Protective conductor terminal.

Chassis (frame) terminal.

On (supply)

Off (supply)

In position of a bi-stable push control

Out position of a bi-stable push control

Notations Used in This Manual

- In this manual, the PAT-T Series regulated DC power supply is often simply referred to as “the PAT.”
- The word “PC” used in this manual is a generic term for personal computers and workstations.
- The following marks are used with the explanations in this manual.

WARNING

Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.

NOTE

Indicates information that you should know.

DESCRIPTION

Explanation of terminology or operation principle.

See

Indicates reference to detailed information.

SHIFT+key name (marked in blue)

Indicates an operation in which a switch marked in blue is pressed while holding down the SHIFT switch.

CFxx : x

The first two characters “CF” indicates a configuration setting, and the next two-digit number indicates the CONFIG parameter number. The character after the colon indicates the selected setting.

⚠ Safety Precautions

The following safety precautions must be observed to avoid fire hazards, electric shock, accidents, and other failures. Keep them in mind and make sure to observe them.

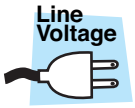
Using the product in a manner that is not specified in this manual may impair the protection functions provided by the product.

Users

- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If an unqualified personnel is to use the product, be sure the product is handled under the supervision of qualified personnel (those who have electrical knowledge). This is to prevent the possibility of personal injury.

Purpose of use

- Never use the product for purposes other than the product's intended use.
- This product is not designed or manufactured for general home or consumer use.

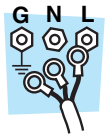


Input power

- Use the product within the rated input power voltage range.
- For applying power, use the power cable provided. For details, see the respective page in the operation manual.
- This product is an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).

Cover

- Some parts inside the product may cause physical hazards. Do not remove the external cover.



Grounding

- This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). To prevent electric shock, be sure to connect the protective conductor terminal of the product to electrical ground (safety ground).

Relocation

- Lower the POWER switch lever to turn it off.
- Remove all wiring.
- When transporting the product, be sure to use the original packing materials.
- The product weighs over 20 kg. When moving the product, have more than one person carry it. The weight of the product is indicated on the rear panel of the product and in the specification table in this manual.
- Be sure to include the manual.

Operation

- Before using the product, be sure to check the input power voltage and that there is no abnormality in the appearance of the power cable. Be sure to turn off the switchboard breaker before checking.
- If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power cable from the switchboard. Make sure the product is not used until it is completely repaired.
- Use cables or wires with sufficiently large current capacity for output wires and load cables.
- Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.

Maintenance and inspection

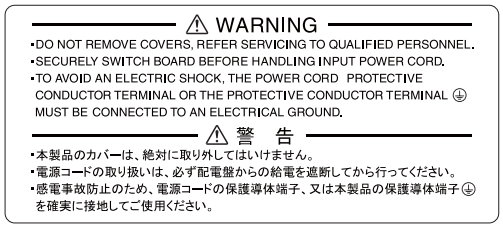
- To prevent electric shock, be sure to unplug the product before carrying out maintenance or inspection. Do not remove the external cover.
- Check periodically that there are no tears or breaks in the power cord and the test lead covering.
- If the panel needs cleaning, gently wipe using a soft cloth with water-diluted neutral detergent. Do not use volatile chemicals such as benzene or thinner.
- To maintain the performance and safe operation of the product, it is recommended that periodic maintenance, inspection, cleaning, and calibration be performed.

Service

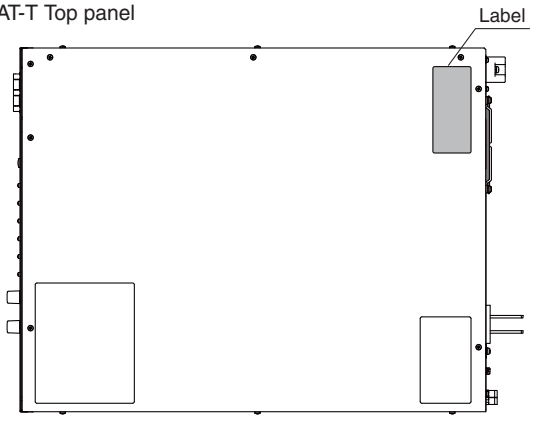
- Kikusui service engineers will perform internal service on the product. If the product needs adjustment or repairs, contact your Kikusui distributor/agent.

Warning label

- There is a warning label affixed to the product. If this label tears or falls off, replace with a new label. If you need a new label, contact your Kikusui agent or distributor.


⚠ WARNING
•DO NOT REMOVE COVERS. REFER SERVICING TO QUALIFIED PERSONNEL.
•SECURELY SWITCH BOARD BEFORE HANDLING INPUT POWER CORD.
•TO AVOID AN ELECTRIC SHOCK, THE POWER CORD PROTECTIVE CONDUCTOR TERMINAL OR THE PROTECTIVE CONDUCTOR TERMINAL ⏚ MUST BE CONNECTED TO AN ELECTRICAL GROUND.
⚠ 警 告
•本製品のカバーは、絶対に取り外してはいけません。
•電源コードの取り扱いは、必ず配電盤からの給電を遮断してから行ってください。
•感電事故防止のため、電源コードの保護導体端子、又は本製品の保護導体端子⏚を確実に接地してご使用ください。

PAT-T Top panel



⚠ Precautions Concerning Installation

Be sure to observe the following precautions when installing the product.

- Do not use the product in a flammable atmosphere.
  To prevent the possibility of explosion or fire, do not use the product near alcohol, thinner or other combustible materials, or in an atmosphere containing such vapors.
- Avoid locations where the product is exposed to high temperature or direct sunlight.
  Do not install the product near a heater or in areas subject to drastic temperature changes.
  Operating temperature range: 0 °C to +50 °C (32 °F to 122 °F)
  Storage temperature range: -25 °C to +70 °C (-13 °F to 158 °F)
- Avoid humid environments.
  Do not install the product in high-humidity locations–near a boiler, humidifier, or water supply.
  Operating humidity range: 20 %rh to 85 %rh (no condensation)
  Storage humidity range: 90 %rh or less (no condensation)
  Condensation may occur even within the operating relative humidity range. If this happens, do not use the product until the condensation dries up completely.
- Be sure to use the product indoors.
  This product is designed for safe indoor use.
- Do not install the product in a corrosive atmosphere.
  Do not install the product in a corrosive atmosphere or in environments containing sulfuric acid mist, etc. This may cause corrosion of various conductors and bad contacts of connectors leading to malfunction and failure, or in the worst case, a fire.
  However, operation in such environments may be possible through alteration. If you want to use the PAT in such environments, consult your Kikusui agent or distributor.
- Do not install the product in a dusty location.
  Accumulation of dust can lead to electric shock or fire.
- Do not use the product where ventilation is poor.
  The product employs a forced air cooling system. Air is taken in from the air inlet on the front panel and exhausted from the air outlet on the rear panel. Secure adequate space around the product to prevent the possibility of fire caused by accumulation of heat.
  Allow at least 20 cm of space between the air inlet/outlet and the wall (or obstacles). Hot air (approximately 20 °C higher than the ambient temperature) is exhausted from the air outlet. Do not place objects that are affected by heat near the air outlet.
- Do not place objects on the product.
  Placing heavy objects on top of the product may cause failures.
- Do not install the product on an inclined surface or location subject to vibrations.
  The product may fall or tip over causing damages and injuries.
- Do not use the product in a location where strong magnetic or electric fields are nearby or a location where large amount of distortion and noise is present on the input power supply waveform.
  The product may malfunction.
- Do not use the product near highly sensitive measuring instruments or transceivers.
  The noise generated by the product may affect them.

Product Overview

The PAT is a low-noise, highly efficient Constant Voltage (CV)/ Constant Current (CC) automatic crossover power supply that employs a software switching system.

Capable to expand the system up to a maximum output of 40 kW by the master-slave parallel operation.

Communication functions for remote control also come standard with the product.

The all models can also receive three-phase 200 Vac and inputthree-phase 400 Vac input. In this manual, the three-phase 400 Vac input models are often simply referred to as “400 V input model.”

Features

- **Reduction of harmonic current and power transmission loss**
  The power-factor improvement circuit reduces the effects of harmonic currents on the input power line. It also suppresses the peak current and reduces the power transmission loss.
- **Master-Slave parallel operation**
  Up to five power supplies can be connected in parallel to expand the output power to 40 kW.
  (You can expand the output power to 16 kW by connecting two PAT850-9.4T power supplies in parallel.)
- **Output limit function**
  You can set the upper limit of current and voltage that is applied when setting the output.
  This function is used to prevent setting inappropriate value by mistake.
- **Remote interface**
  Equipped with RS232C as standard. You can select the GPIB, USB or LAN interface as a factory option.
  The remote interface complies with IEEE 488.2 std 1992 and SCPI Specification 1999.0. Because the LAN interface complies with the LXI standard, the construction of a highly cost-effective system is possible.
- **High efficiency and low noise**
  The PAT is a highly efficient, low-noise power supply that employs a software switching system.
  High power conversion efficiency has reduced the rise in the internal temperature and has contributed to the product’s compact and light design.
- **Downsized input distribution device**
  The input distribution device (breaker) can be downsized, because the built-in power-factor improvement circuit reduces the required input current.
- **Preset memory function of settings**
  Up to three output setting presets (combination of current and voltage) can be saved.
  You can simply select a preset to set the output without having to set the voltage and current every time you use the PAT.
- **Output on/off delay function**
  You can set a delay until the output is actually turned on or off after turning the OUTPUT switch on or off.
  For example, this feature is useful if you want to turn the output on/off by setting a time offset according to the load characteristics.

Contents

Safety Symbols i
Notations Used in This Manual i
Safety Precautions ii
Precautions Concerning Installation iii
Product Overview iv
Features iv
Contents by Function vii
Front panel viii
Rear panel x

1 Installation and Preparation

1.1 Checking the Package Contents 1-2
1.2 Rack Mounting the Product 1-3
1.3 Connecting the Power Cable 1-4
1.4 Turning On 1-6

2 Connecting the Load

2.1 Load Considerations 2-2
2.2 Load Cable 2-4
2.3 Connecting to the Output terminal 2-6

3 Basic Operation

3.1 Measured Value Display and Setting Display (Setting the Output Voltage and Output Current) 3-2
3.2 Output Operation 3-3
3.3 Constant Voltage (CV) and Constant Current (CC) Power Supplies 3-5
3.4 Using the PAT as a CV or CC Power Supply (Setting the Output Voltage and Output Current) 3-7
3.5 Protection Functions and Alarms 3-8
3.5.1 Overvoltage protection (OVP) and overcurrent protection (OCP) 3-9
3.5.2 Other Protection Functions 3-12
3.6 CONFIG Settings 3-14
3.7 Preset Memory Function 3-23
3.8 Lock Function 3-24
3.9 Switching from Remote to Local Mode 3-25
3.10 Remote Sensing Function 3-25
3.11 Factory Default Settings 3-28

4 External Control

4.1 Overview of External Control 4-2
4.2 J1 Connector 4-2
4.3 Output terminal Insulation 4-5
4.3.1 When the Output terminal Is Not Grounded (Floating) 4-6
4.3.2 When the Output terminal Is Grounded 4-7
4.4 Controlling the Output Voltage 4-9
4.4.1 External Voltage (Vext) Control 4-9
4.4.2 External resistance (Rext) control 4-11

4.5 Controlling the Output Current 4-13
4.5.1 External Voltage (Vext) Control 4-13
4.5.2 External Resistance (Rext) Control 4-15
4.6 Controlling the Output On/Off 4-17
4.7 Shutdown Control Using External Contact 4-19
4.8 External Monitoring 4-21

5 Parallel/Series Operation

5.1 Master-Slave Parallel Operation 5-2
5.1.1 Functions during Master-Slave Parallel Operation 5-2
5.1.2 Connection (Parallel Operation) 5-4
5.1.3 Master-Slave Parallel Operation Setup 5-7
5.1.4 Starting the Master-Slave Parallel Operation 5-8
5.2 Series Operation 5-9
5.2.1 Functions during series operation 5-9
5.2.2 Load Connection (Series Operation) 5-11
5.2.3 Series Operation Setup 5-12
5.2.4 Starting the Series Operation 5-12

6 Remote Control

6.1 Remote Control Overview 6-2
6.2 Interface Setup 6-3
6.2.1 RS232C Control (Standard Equipped) 6-3
6.2.2 GPIB Interface (Option) 6-5
6.2.3 USB Interface (Option) 6-6
6.2.4 LAN interface (Option) 6-7
6.3 Contents of the Included CD-ROM 6-9
6.4 Installing the VISA library 6-10
6.5 Command Details 6-11

7 Maintenance

7.1 Inspection 7-2
7.2 Cleaning 7-2
7.3 Calibration 7-5
7.3.1 Calibration Overview 7-5
7.3.2 Calibration Procedure 7-6

8 Specifications

Appendix
A.1 Options A-2
A.2 Troubleshooting A-4

Index

Contents by Function

Preparation

• I want to check the accessories.	➔1.1, “Checking the Package Contents”	p. 1-2
• The installation space is limited. How much space is needed around the air inlet and outlet?	➔“Precautions Concerning Installation”	p. iii
• How do I connect the AC power supply?	➔1.3, “Connecting the Power Cable”	p. 1-4
• What kind of wires should be used to connect to the AC power supply?	➔1.3, “Connecting the Power Cable”	p. 1-4
• What kind of wires should be used to connect the load?	➔2.2, “Load Cable”	p. 2-4
• The wire connecting the load is long (distance to the load is long), but stable voltage is required.	➔3.10, “Remote Sensing Function”	p. 3-25
• How do I rack mount the PAT? What kind of parts is needed?	➔“ Options”	p. A-2

Setting

• How do I set the communication conditions for remote control?	➔6.2, “Interface Setup”	p. 6-3
• How do I control the output voltage using an external DC voltage?	➔4.4.1, “External Voltage (Vext) Control”	p. 4-9
• How do I increase the current capacity in parallel operation?	➔5.1, “Master-Slave Parallel Operation”	p. 5-2
• How do I reset the PAT to factory default settings?	➔3.11, “Factory Default Settings”	p. 3-28

Operation

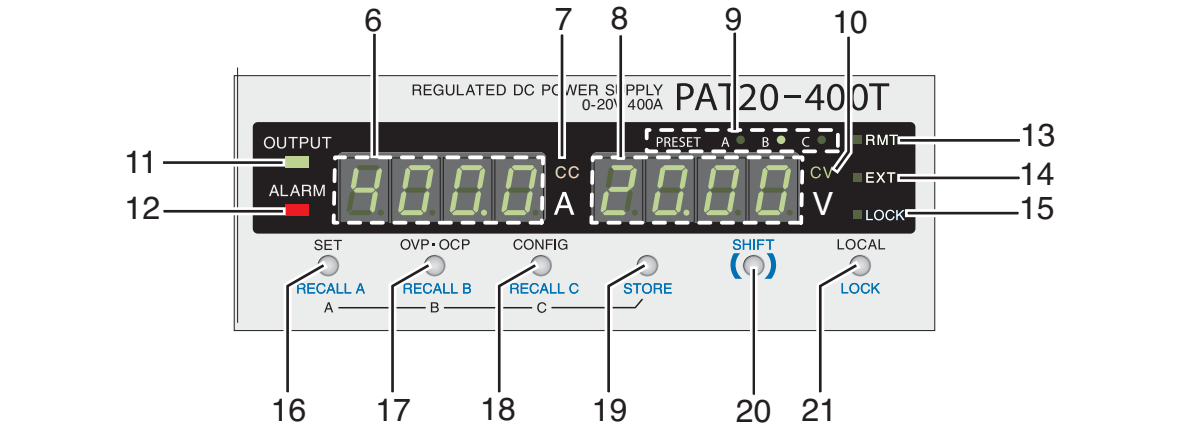
• How can I use the PAT as a constant voltage power supply (CV)?	3.4, “Using the PAT as a CV or CC Power Supply (Setting the Output Voltage and Output Current)” ➔	p. 3-7
• How can I use the PAT as a constant voltage current supply (CC)?		
• I would like to operate the PAT at a given voltage. How do I register the voltage in the preset memory?	➔3.7, “Preset Memory Function”	p. 3-23
• How do I set the upper limit to prevent the voltage from being increased too much?	➔“ Setting limit function”	p. 3-10
• How do I set the voltage in fine resolution?	➔“ Fine adjustment function”	p. 3-7
• How do I set the protection function to prevent damage to the load?	➔3.5, “Protection Functions and Alarms”	p. 3-8
	➔3.5.1, “Overvoltage protection (OVP) and overcurrent protection (OCP)”	p. 3-9
• How do I cut off the output at a different time from other power supplies?	➔“ Output on/off delay functions”	p. 3-4
• How can I monitor the output voltage and output current?	➔4.8, “External Monitoring”	p. 4-21
• How do I temporarily lock the keys?	➔3.8, “Lock Function”	p. 3-24
• How do I use the sample program for remote control?	➔For information about remote control, see the accompanying CD-ROM.	---
• How do I display a slave unit's current during parallel operation?	5.1.1, “Functions during Master-Slave Parallel Operation”	p. 5-2

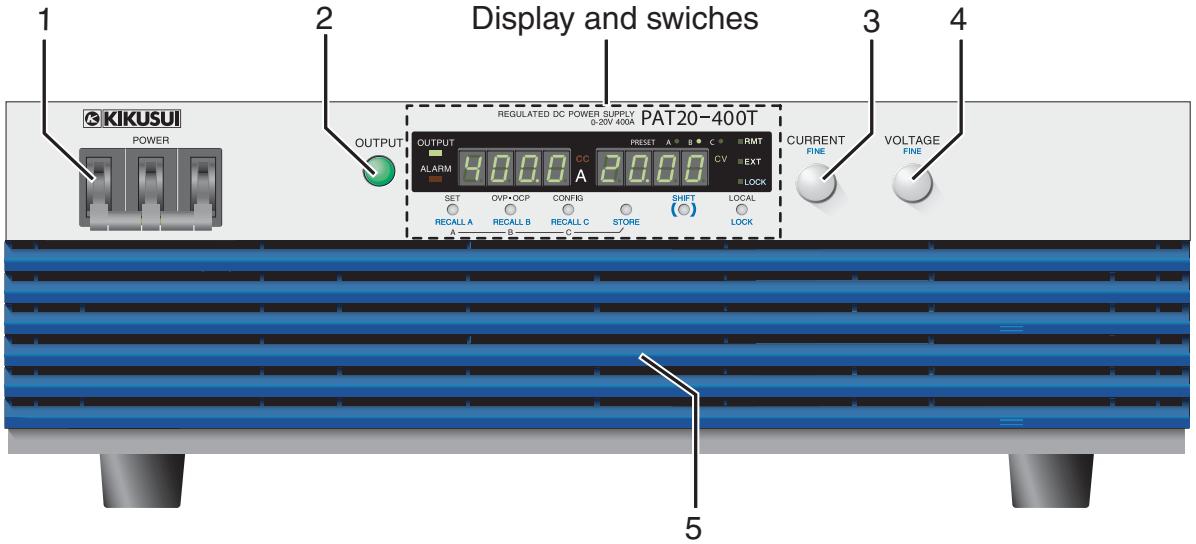
Maintenance

• How do I clean the dust filter?	➔“Cleaning the Dust Filter”	p. 7-2
• How do I check for breaks and tears in the insulation?	➔7.1, “Inspection”	p. 7-2
• How do I calibrate the PAT-T series?	➔7.3, “Calibration”	p. 7-5

Trobleshooting... See “A.2 Troubleshooting” on page A-4

Front panel

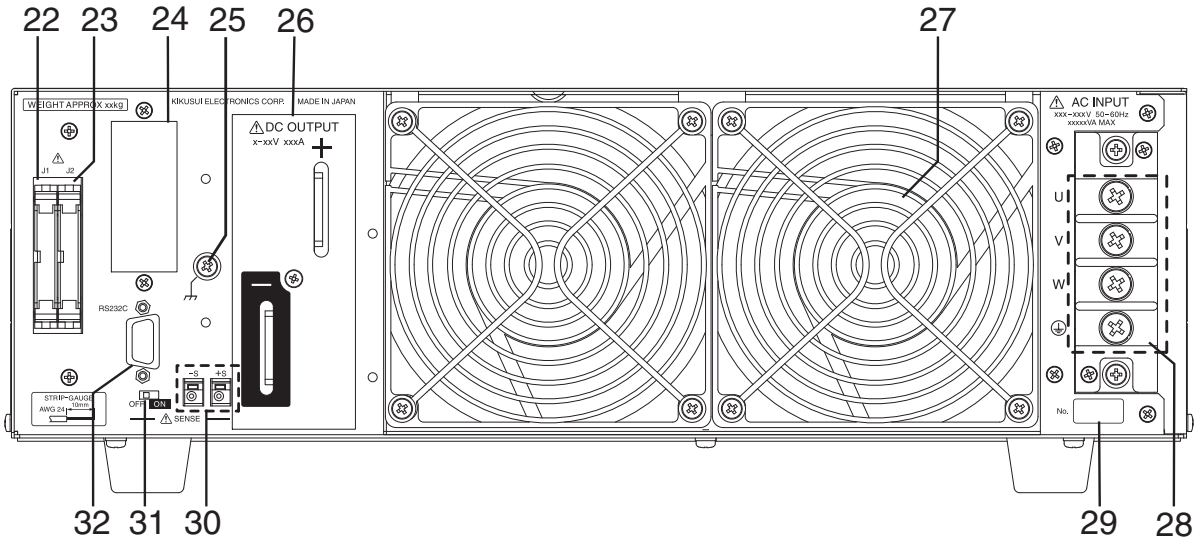




Examples of PAT20-400T

No.	Name	+SHIFT	Function	See Page
1	POWER		Power on/off lever Raise the lever to turn the power on (❙). Lower to turn the power off (◯).	1-6
2	OUTPUT		Output on/off switch.	3-3
3	CURRENT knob		Used to set the current value or select the CONFIG parameter number.	–
		FINE	Current adjustment knob when the fine adjustment function is enabled.	3-7
4	VOLTAGE knob		Used set the voltage value or change the CONFIG parameter setting.	–
		FINE	Voltage adjustment knob when the fine adjustment function is enabled.	3-7
5	Air inlet (louver)		Inlet for taking in air from the outside. A dust filter is built in.	7-2
6	Ammeter		Displays the current value or the CONFIG parameter number.	–
7	CC		Illuminates in constant current mode.	3-7
8	Voltmeter		Displays the voltage value or the CONFIG parameter setting.	–
9	PRESET		The LED of the preset memory in use illuminates.	3-23
10	CV		Illuminates during constant voltage mode.	3-7
11	OUTPUT LED		Illuminates when output is on and turns off when output is off.	3-2
12	ALARM LED		Illuminates when a protection circuit is activated.	3-8
13	RMT LED		Illuminates when operating in remote control.	3-25
14	EXT LED		Illuminates when operating in external control.	4-2
15	LOCK LED		Illuminates when panel operations except turning the output on/off and viewing settings.	3-24
16	SET		Switch with an LED for setting and checking the output voltage or output current.	3-7
	–	RECALL A	Switch for recalling the value of preset memory A	3-23
	A		Switch for saving the value to preset memory A. Press STORE and then A.	3-23
17	OVP•OCP		Switch with an LED for setting and checking the trip points of the overvoltage protection (OVP) and overcurrent protection (OCP).	3-9
	–	RECALL B	Switch for recalling the value of preset memory B	3-23
	B		Switch for saving the value to preset memory B. Press STORE and then B.	3-23
18	CONFIG		Switch with an LED for setting various conditions concerning the operation.	3-14
	–	RECALL C	Switch for recalling the value of preset memory C	3-23
	C		Switch for saving the value to preset memory C. Press STORE and then C.	3-23
19	–		–	–
		STORE	Switch for storing the preset memory	3-23
20	SHIFT		Switch for calling up the functions marked in blue characters.	i
21	LOCAL		Switch for changing between remote and local modes.	3-25
		LOCK	Switch for disabling only the operations that change the settings (keeping the display and recall operations enabled).	3-24

Rear panel



No.	Name	Function	See Page
22	J1	Connector for external analog control.	4-2
23	J2	Connector for parallel operation.	5-4
24	Option slot	Slot for installing the optional interface board (GPIB, USB or LAN). A factory option.	6-5 6-6
25	Chassis terminal	Terminal used to ground the output.	2-6
26	DC OUTPUT	Output terminal.	2-4 2-6
27	Air outlet	Exhaust port for cooling.	iii
28	AC INPUT	Input terminal.	1-4
29	Serial number	The serial number of the PAT.	–
30	Sensing terminal	A terminal used to connect the sensing wires.	3-25
31	Sensing switch	Switch for enabling/disabling remote sensing.	
32	RS232C	Connector for the RS-232C cable.	6-3

1

Installation and Preparation

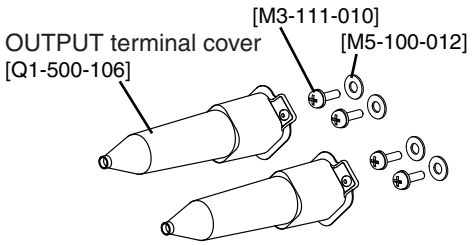
This chapter describes the procedures of unpacking and preparation of the PAT before use.

1.1 Checking the Package Contents

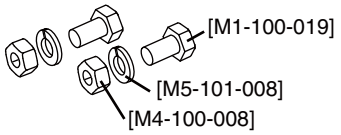
When you receive the product, check that all accessories are included and that the accessories have not been damaged during transportation.

If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

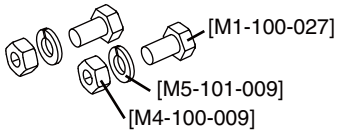
We recommend that all packing materials be saved, in case the product needs to be transported at a later date.



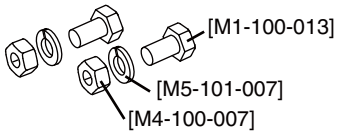
☐ OUTPUT terminal cover set (2 sets)



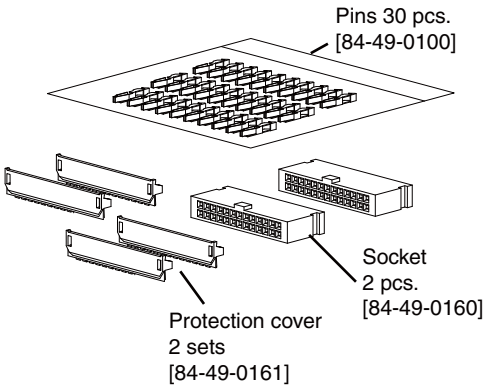
☐ Output terminal bolt (M10) (2 sets)
(PAT40-200T/60-133T/80-100T/160-50T)



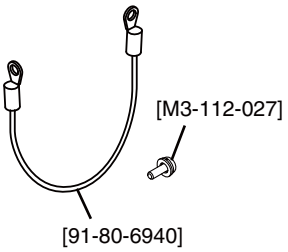
☐ Output terminal bolt (M12) (2 sets)
(PAT20-400T/30-266T)



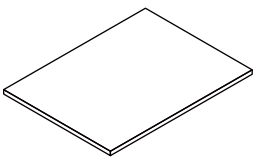
☐ Output terminal bolt (M8) (2 sets)
(PAT250-32T/350-22.8T/500-16T
/650-12.3T/850-9.4T)



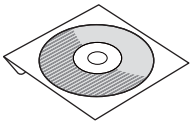
☐ J1/J2 connector kit



☐ Chassis connection wire set (1 set)



☐ User's manual (This manual, 1 pc.)
[Z1-004-772]



☐ CD-ROM (1 pc.)
[SA-6038]

Fig.1-1 Accessories

1.2 Rack Mounting the Product

See p. 1-3

Remove the rubber feet before rack mounting the product to a frame. Fig.1-2 shows how to remove the rubber feet.

For details on rack mounting, see the KRB3-TOS or KRB150-TOS Operation Manual.

Install the suitable support angles applying to the used rack system to support the instrument.

We recommend that you keep all the parts so that you can use them again when you detach the product from the frame.

To reattach the rubber feet, use the screws that you removed.

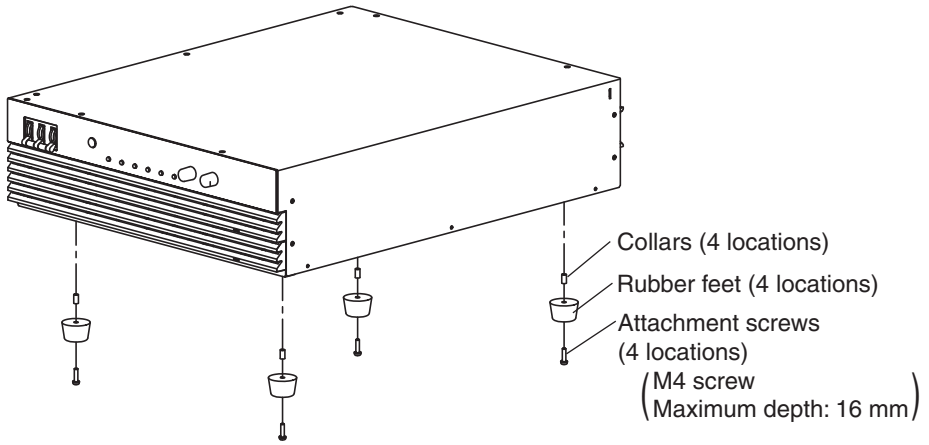


Fig.1-2 Removing the rubber feet

Removing the rubber feet

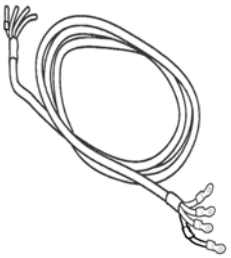
Unfasten the screws and remove the four rubber feet.

1.3 Connecting the Power Cable

This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).

See p. 1-4

This product does not come with a power cable. The optional power cable (AC8-4P4M-M6C) has crimping terminals (round M6 terminals, 12 mm wide) attached on its PAT end. However, the switchboard end of the power cable has not been prepared for connection. When you use the cable, attach crimping terminals to it that match the screws of the switchboard that you will connect it to.



Three-phase power cable
(AC8-4P4M-M6C)

Fig.1-3 Optional power cable

Exercise the following precautions when preparing the power cable.

⚠WARNING **Possible electric shock.**

- **Turn off the switchboard breaker (switch that cuts off the power supply from the switchboard) before making the connection.**
- **This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). Be sure to ground the product to prevent electric shock.**
- **Connect the ground terminal to earth ground.**
- **Be sure to have a qualified engineer connect the power cable to the switchboard.**

⚠CAUTION

- Inside the power supply, an appropriate protective circuit is connected to the input terminal. Be sure to connect the wires correctly by matching the U, V, W, and ⏚(GND) between the switchboard and the product.

NOTE

- The POWER switch of the product can be used to disconnect the product from the AC line in an emergency. Provide adequate space around the POWER switch so that the POWER switch can be turned off at any time.

Use a four-core PVC insulated cable for 600 Vac with a nominal cross-sectional area of at least 8 mm^2 (At least 5 mm^2 for 400 V input model.)

Connection procedure

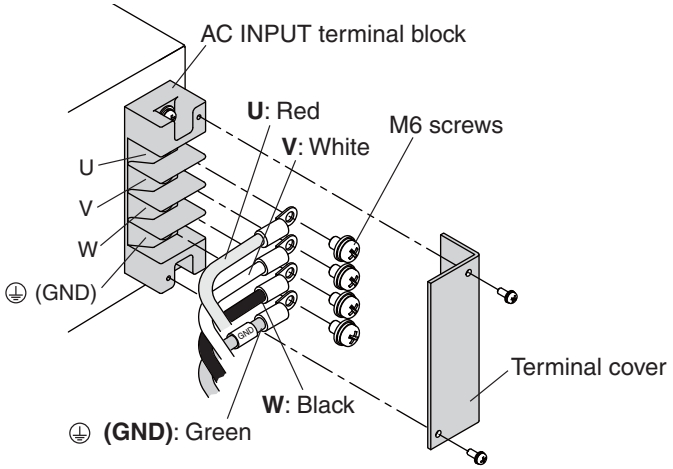


Fig.1-4 Connecting the power cable
(example in which the optional power cable is used)

1 Check that the AC power line meets the nominal input rating of the product.

A model with a nominal input rating of 200 Vac to 240 Vac can receive voltages within the range of 180 Vac to 250 Vac. 400 V input models (whose nominal input rating is 400 Vac) can receive voltages within the range of 360 Vac to 440 Vac. The frequency is 50 Hz or 60 Hz.

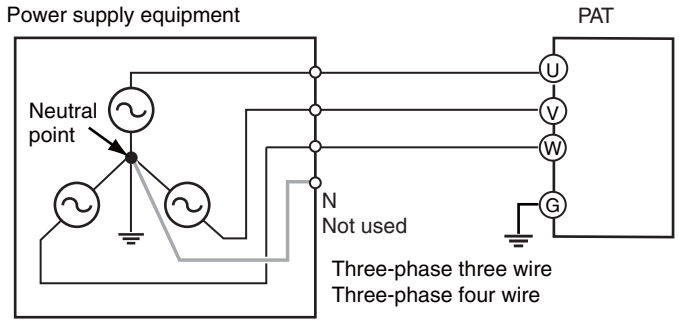


Fig.1-5 Required power supply equipment

⚠CAUTION The PAT may be damaged.

- Do not connect a 400 V input model to a power line if the voltage between any of the line's phase terminals and the ground shown in Fig.1-5 exceeds 254 Vac.

2 Check that the POWER switch is turned off.

3 Attach crimping terminals to the cable that are appropriate for the PAT, and then connect the cable to the AC INPUT terminal block as shown in Fig.1-4.

4 Attach appropriate crimp terminals to the switchboard end of the power cable.

5 Turn off the switchboard breaker.

6 Connect the power cable by matching the U, V, W, and ⏚(GND) of the switchboard.

Precautions Concerning Grounding (Earth)

Be sure to ground the product for your safety.

Make sure to connect the GND terminal of the AC INPUT terminal block to the GND terminal of the switchboard.

1.4 Turning On

⚠CAUTION

- The CONFIG parameters can be configured so that the output is automatically turned on when the POWER switch is turned on. When this function is enabled, the PAT powers up with the output turned on even if the output was off when the PAT was turned off the last time. However, there is a possibility that a load may break, if you connect a different load and turn the POWER and output on simultaneously without changing the OVP and OCP settings to appropriate values.

Turning the POWER switch on

1 Check that the power cable is correctly connected.

2 Raise the lever and turn the POWER switch on.

If an odd sound, odd odor, fire, or smoke occurs around or in the PAT, lower the POWER lever to turn it off.

3 Check the firmware version on the front panel display.

See p. 3-2

The voltmeter and ammeter show the PAT firmware version for approximately 1 second. The measuring value will be shown after the firmware version is displayed.

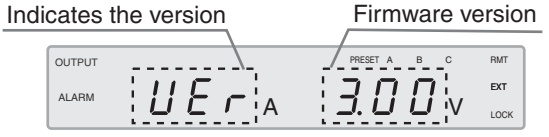


Fig.1-6 Firmware version display at power-on (example for Ver.3.00)

See p. 3-28

If the POWER switch is turned on for the first time after purchasing the PAT, the PAT starts up in a factory default condition.

An inrush current flows up to 100 Amax. (40 Amax. for 400 V input model) when the POWER switch is turned on. In particular, check that sufficient current capacity

is available in the AC power line and the switchboard if you are using multiple PATs and turning on the POWER switches simultaneously.

If front panel display shows indicated in Table 1-1 after power-on, follow the corresponding remedy. If the remedy does not correct the problem, contact your Kikusui agent or distributor.

Table 1-1 Panel display during and after power-on

Panel Display		Cause and Remedy
SYS1 ERR	SYS1 Err	The PAT may have malfunctioned. Contact your Kikusui agent.
SYS2 ERR	SYS2 Err	The calibration has not been completed normally. Recalibrate. If "SYS2 ERR" appears even after recalibration, the PAT may have malfunctioned. Contact your Kikusui agent. (See p. 7-5)
CLR ABC	CLr ABC	Preset memories A, B, and C have been reset to factory default settings because the values were abnormal. To continue the operation, press any panel switch.
CLR SET	CLr SEt	The voltage and current calibration values have been reset to factory default settings, because the values were abnormal. To continue the operation, press any panel switch.
CLR CONF	CLr CONF	The CONFIG settings have been reset to factory default values, because the values were abnormal.To continue the operation, press any panel switch.

Turning the POWER switch off

Lower the POWER switch lever to turn it off.

When the POWER switch is turned off, the front panel display shows the characters indicated in the following figure for about 10 to 15 seconds.

Fig.1-7 Display at power-off

The PAT stores the panel settings (excluding output on/off condition) immediately before the POWER switch is turned off. For these items, the PAT starts up using the settings that existed when the POWER switch was turned off the last time.

If the POWER switch is turned off immediately after changing the settings, the last settings may not be stored.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds (40 seconds for 400 V input model) after the fan stops. Repeated ON/OFF of the POWER switch at short intervals can cause damage to the inrush current limiter or shorten the service life of the POWER switch and the internal input fuse.

2

Connecting the Load

This chapter describes the consideration to be given to the load, explains how to connect the load wires, and explains how to connect to the output terminals.

2.1 Load Considerations

Note that the output will become unstable if the following types of loads are connected.

Load with peaks and pulse-shaped current

The PAT indicates only mean values. Even when the indicated value is less than the preset current value, the peak values may actually exceed the preset current value. If this happens, the PAT is instantaneously put into constant-current operation mode, and the output voltage drops accordingly.
For these types of loads, you must increase the preset current value or increase the current capacity.

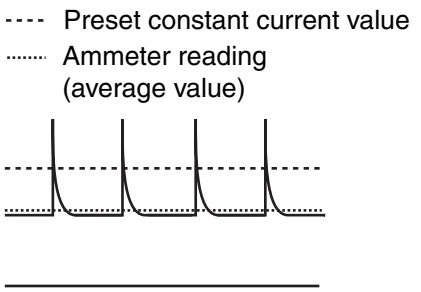


Fig.2-1 Load current with peaks

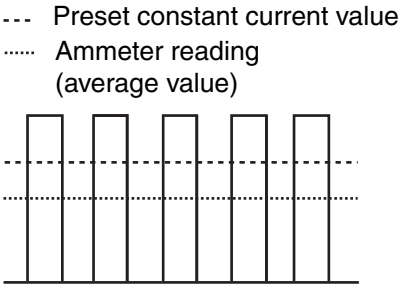


Fig.2-2 Pulse-shaped load current

Load that generates reverse current to the power supply

The PAT cannot absorb reverse current from the load. Therefore, if a regenerative load (such as an inverter, converter, or transformer) is connected, the output voltage increases and becomes unstable.
For these types of loads, connect a resistor R_D as shown in Fig.2-3 to bypass the reverse current. However, the amount of current to the load decreases by max. reverse current I_{rp}.

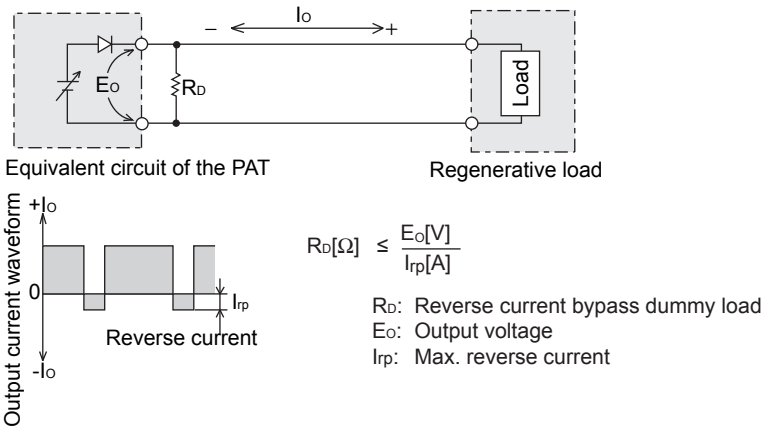


Fig.2-3 Remedy for regenerative load

⚠CAUTION

- Use a resistor with sufficient rated power for resistor R_D.
- If a resistor with insufficient rated power for the circuit is used, resistor R_D may burn out.

Load with accumulated energy

Connecting a load with accumulated energy, such as a battery, to the PAT may cause current to flow from the load to the internal circuit of the PAT. This current may damage the PAT or reduce the life of the battery.
For this type of loads, connect a reverse-current-prevention diode (D_{RP}) between the PAT and the load in series as shown in Fig.2-4.

This cannot be used in conjunction with remote sensing.

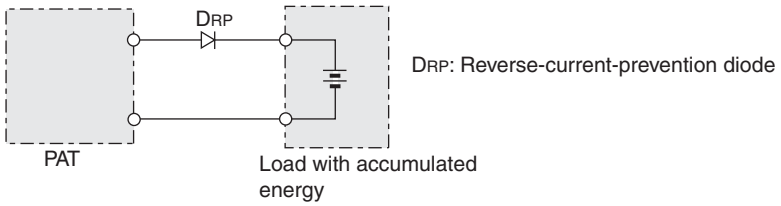


Fig.2-4 Remedy against load with accumulated energy

⚠CAUTION

- Use a reverse-current-prevention diode (D_{RP}) complied to the following references.
  Reverse voltage withstand capacity :
  At least twice the rated output voltage of the PAT.
  Forward current capacity :
  Three to ten times the rated output current of the PAT.
  A diode with small loss.
- Be sure to take into account the heat generated by reverse-current-prevention diode D_{RP}. Reverse-current-prevention diode D_{RP} may burn out with inadequate heat dissipation.

2.2 Load Cable

⚠WARNING To prevent the possibility of fire.

- **Use a load cable with sufficient current capacity with respect to the rated output current of the PAT.**
- **The output terminal and its area nearby gets very high temperature, use the cable with sufficient heat resistance higher than 85 °C of the covering materials.**

Possible electric shock.

- **Use a load cable with a higher voltage rating than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**

■ Current capacity of the load cable

If their current rating exceeds the maximum rated output current, the cable will remain intact even if the load is short-circuited. Load cables must be rated to carry the maximum rated output current of the PAT.

■ Allowable current of the cable dependent on the maximum allowable temperature of the cable insulation

The cable temperature is determined by a current-caused resistance loss, ambient temperature, and thermal resistance to the outside. Table 2-1 shows the allowable capacity of current that can flow through a heat-resistant PVC wire (single wire) having a maximum allowable temperature of 60 °C when the wire is stretched horizontally in the air at an ambient temperature of 30 °C. If the condition is such that PVC wires with lower heat-resistant temperature are used, the ambient temperature exceeds 30 °C, or the wires are bundled resulting in low heat radiation, the current capacity needs to be reduced.

Table 2-1 Nominal cross-sectional area of cables and allowable currents

Nominal cross-sectional area [mm^2]	AWG	(Reference cross-sectional area) [mm^2]	Allowable current*1 [A] (Ta = 30 °C)	Current recommended by Kikusui [A]
2	14	(2.08)	27	10
3.5	12	(3.31)	37	-
5.5	10	(5.26)	49	20
8	8	(8.37)	61	30
14	6	(13.3)	88	50
22	4	(21.15)	115	80
30	2	(33.62)	139	-
38	1	(42.41)	162	100
50	1/0	(53.49)	190	-
60	2/0	(67.43)	217	-
80	3/0	(85.01)	257	200
100	4/0	(107.2)	298	-
125	-	-	344	-
150	-	-	395	300
200	-	-	469	400

*1. Excerpts from Japanese laws related to electrical equipment.

■ Taking measures against noise

When connecting wires that have the same heat-resistant temperature, more current can flow by separating the wires to make heat radiation as great as possible. However, installing the + (pos.) and - (neg.) output wires of the load cable side by side or bundling them together is more effective against unwanted noise. The Kikusui-recommended currents shown in Table 2-1 are allowable current values that have been reduced in consideration of the potential bundling of load cables. Use these values as a guideline when connecting load cables.

■ Limitations of the sensing function

All wires have resistance. The voltage drop in wires becomes greater as the wire becomes longer or the current becomes larger. This results in the voltage applied at the load end to be smaller. The PAT has a sensing function that compensates for this voltage drop up to approximately 0.6 V for a single line. If the voltage drop exceeds this level, wires having a greater sectional area should be used.

2.3 Connecting to the Output terminal

⚠WARNING Possible electric shock.

- **Be sure to turn the POWER switch off before touching the output terminal.**
- **Be sure to attach the OUTPUT terminal cover after wiring the load.**

Connection procedure

See p. 3-25

After the installation of the OUTPUT terminal cover for the output terminal, the portion of the terminal cover is on top of the sensing terminal. In case the remote sensing is used, install the OUTPUT terminal cover after wiring of the sensing cable.

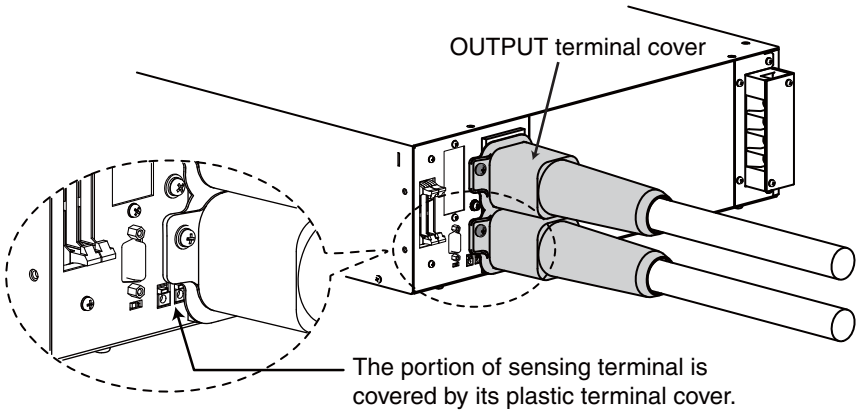


Fig.2-5 Attachment completion of the OUTPUT terminal cover

■ How to use the OUTPUT terminal cover for the output terminal

Cut the sleeve of the OUTPUT terminal cover for the appropriate size of the load cable which goes through its OUTPUT terminal cover.

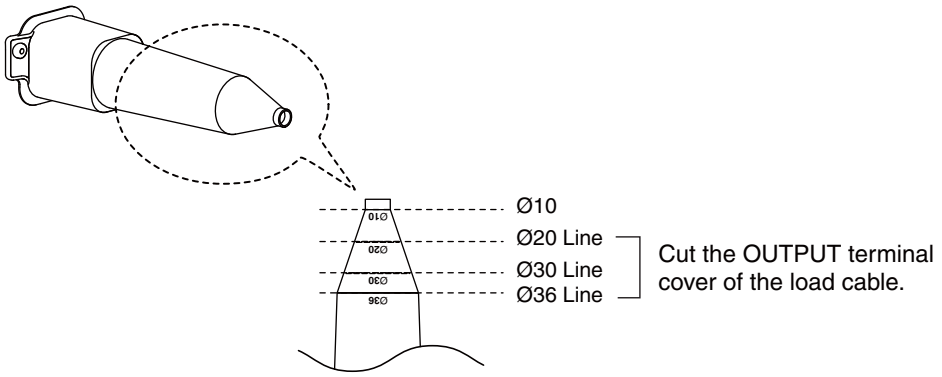


Fig.2-6 OUTPUT terminal cover

Connection preparation

1 Turn the POWER switch off.

2 Using the chassis connection wire set that comes with the package, connect the chassis terminal to either the negative or positive DC output terminal.

The output terminal has a hole used to connect the chassis connection cable that comes with the package.

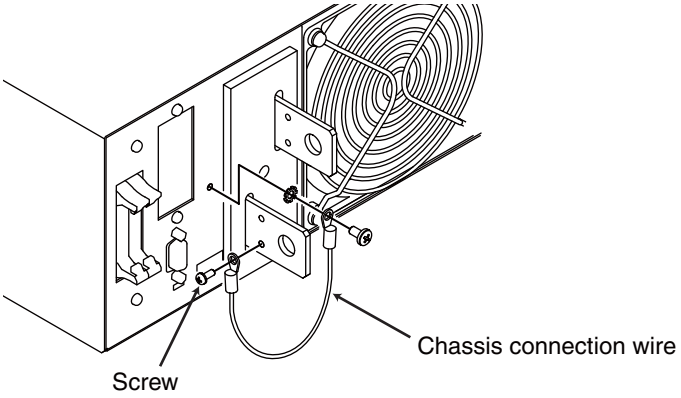


Fig.2-7 Connecting the chassis connection wire

3 Attach crimping terminals to the load cable.

See p. 8-4, p. 8-7

The output terminal has a hole for connecting the load cable. Attach the crimping terminal that matches the bolt used.

4 Insert the load cable through the OUTPUT terminal cover.

5 Connect the load cable on the rear panel.

Insert the bolt for the positive (+) terminal from right side, and the negative (-) terminal from left side as you face, then fix it using the nut and spring washers. Connect the load cable straight forward (vertical angle against the surface of the output terminal).

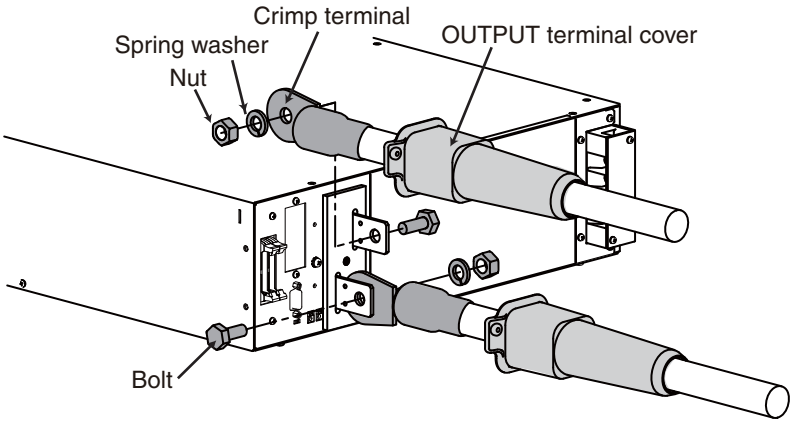


Fig.2-8 Connection of the load cable

6 Install the OUTPUT terminal cover on the rear panel.

Uses the attached screws to install the OUTPUT terminal cover firmly and make sure they are not loosen.

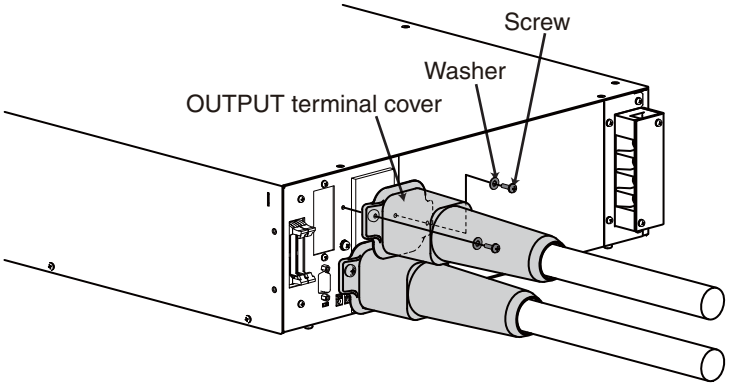


Fig.2-9 Attachment of the OUTPUT terminal cover

3

Basic Operation

This chapter describes how to turn on/off the output and the basic operations that you can carry out from the front panel.

3.1 Measured Value Display and Setting Display (Setting the Output Voltage and Output Current)

The panel display has two modes. One mode displays the measured values of the output voltage and output current, and the other mode displays the settings. These two modes can be distinguished by the on/off state of the SET, OVP•OCP, and CONFIG switches.

■ Measured value display

The measured value display shows the present output terminal voltage and load current. In this mode, the LEDs of the SET, OVP•OCP, and CONFIG switches are all off.

See p. 3-7

You can change the output voltage and current settings in the measured value display mode.

Fig.3-1 Measured value display example

■ Setting display

The following three states are available.

- Setting display of the output voltage and output current

  Press the SET switch. The switch LED illuminates. The present output voltage and current are displayed.

Fig.3-2 Setting display example of the output voltage and output current

See p. 3-23

If you save or recall a preset memory, the panel display shows the preset memory values.

- Setting display of the overvoltage and overcurrent protection

  Press the OVP•OCP switch. The switch LED illuminates. The present overvoltage and overcurrent settings are displayed.

Fig.3-3 Setting display example of the overvoltage and overcurrent protection

- Setting display of the system configuration

  Press the CONFIG switch. The switch LED illuminates.The system configuration settings are displayed.

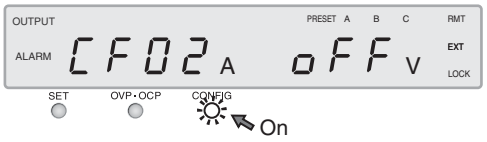


Fig.3-4 Setting display example of the system configuration

3.2 Output Operation

The OUTPUT switch is a toggle switch.

When you press the OUTPUT switch and the output turns on, the OUTPUT LED illuminates. When you press the OUTPUT switch and the output turns off, the OUTPUT LED turns off.

If the output is turned on, the present setting is output. If you change the setting while the output is on, the change is applied to the output.

See p. 4-17

It is possible to control on/off of the output by external control.

Fig.3-5 Output on display example

Output on/off when power is turned on

By factory default, the output is off when the power is turned on. You can set the output state at power-on to on (CF25: ON) in the CONFIG settings.

If you set the output state at power-on to on, check the OVP trip point setting before you turn off the POWER switch.

If the breaker trip setting that is applied when an OVP or OCP activates is set to “trip” (CF28: ON) and the OVP trip point is set lower than the output voltage setting, the OVP will activate every time you turn the POWER switch on and the POWER switch will turn off.

See p. 3-28
p. 4-17

If the condition above occurs and you are unable to change any of the settings, turn the POWER switch on while holding down the SHIFT switch to reset the PAT to factory default settings.

⚠CAUTION

- If the OVP/OCP settings are not appropriate when you change the load, the load may break.

Output on/off delay functions

See p. 3-16

You can set a delay (0.1 s to 10.0 s) until the output is actually turned on or off after you turn the OUTPUT switch on or off. This function is useful if you want to turn the output on/off by setting a time offset according to the load characteristics.

To enable this function, set the output on delay (CF10: 0.1 to 10.0) and output off delay (CF11: 0.1 to 10.0) of the CONFIG parameter. You can set separate delays for on and off.

The OUTPUT LED blinks while the output on/off delay function is in operation.

Press the OUTPUT switch while the OUTPUT LED is blinking to cancel the output on/off delay.

Press the OUTPUT switch while holding down the SHIFT switch while the OUTPUT LED is blinking to cancel the output on/off delay and forcibly switch the output.

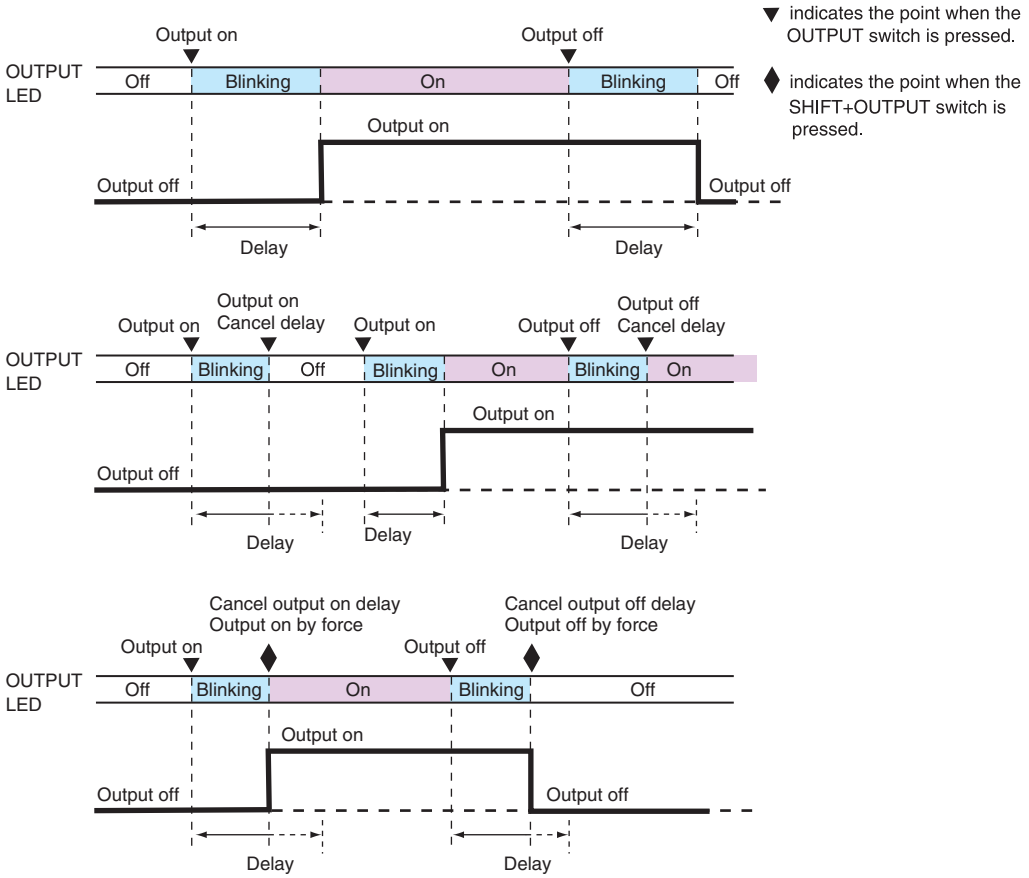


Fig.3-6 Output on/off delay action

Setting the output-on startup state

See p. 3-19

When the output state at power-on is set to on, you can choose to make the PAT start as a constant voltage (CV) power supply or as a constant current (CC) power supply.

To use this function, set the output-on startup state (CF32: CV/CC) in the CONFIG settings. To start the PAT as a constant voltage (CV) power supply, select CV prioritization (CF32: CV). To start the PAT as a constant current (CC) power supply, select CC prioritization (CF32: CC).

3.3 Constant Voltage (CV) and Constant Current (CC) Power Supplies

The PAT has a constant voltage power supply function that maintains the output voltage at a constant level and a constant current power supply function that maintains the output current at a constant level even when the load changes. The condition in which the PAT is operating as a constant voltage power supply is called the constant voltage (CV) mode. The condition in which the PAT is operating as a constant current power supply is called the constant current (CC) mode. The operation mode is determined by the following three values.

- Preset output voltage (Vs)
- Preset output current (Is)
- Load resistance (RL)

The operation modes are described below.

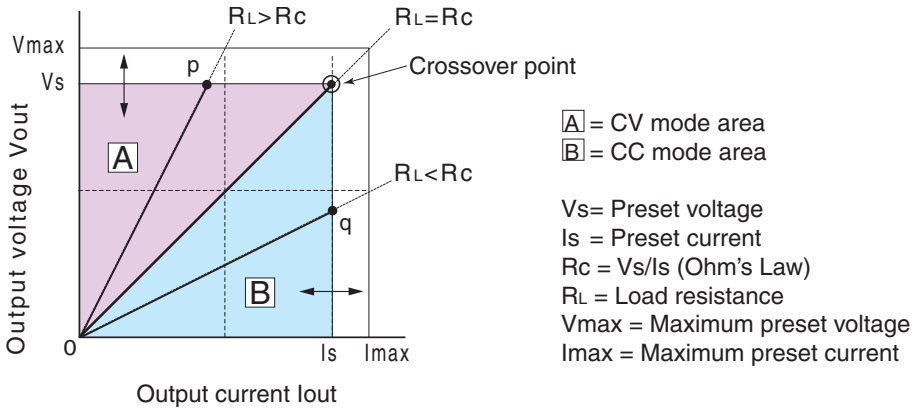


Fig.3-7 Constant voltage operation and constant current operation

Fig.3-7 shows the operation modes of the PAT. We denote the load resistance as RL and the resistance calculated from the preset current and voltage as Rc (Rc = Vs/Is). The power supply is designed so that it operates in CV mode in area A and CC mode in area B. The boundary is the line defined by RL = Rc. This line represents the load at which the output voltage and the preset voltage are equal and the output current and preset current are equal. If load resistance RL is greater than resistance Rc, the operating point is in area A, and the PAT operates in CV mode (point p). In this case, preset current Is is the current limit.

When operating in CV mode, the output voltage is maintained at the preset voltage. Output current I is determined by the relationship defined by the equation I = Vs/RL. It is a current less than current limit Is. In this mode, the actual current that flows is not necessarily equal to the specified value.

For loads in which transient peak current flows, preset current Is must be set so that the peak value does not reach the current limit.

Conversely, if load resistance RL is less than resistance Rc, the operating point is in area B, and the PAT operates in CC mode (point q). In this case, preset voltage Vs is the voltage limit.

When operating in CC mode, the output current is maintained at the preset current. Output voltage V is determined by the relationship defined by the equation V = Is × RL. It is a voltage less than voltage limit Vs. In this mode, the actual voltage that is applied is not necessarily equal to the specified value.

For loads that generate transient surge voltage, preset voltage Vs must be set so that the surge voltage does not reach the voltage limit.

■ Crossover point

CV mode and CC mode switch automatically according to the changes in the load. The point at which the mode switches is called the crossover point.

For example, if the load changes and the output current reaches the current limit when operating in CV mode, the operation mode automatically switches to CC to protect the load. Likewise, if the output voltage reaches the voltage limit when operating in CC mode, the operation mode automatically switches to CV.

CV and CC mode operation example

This section uses a power supply with a rated output voltage of 100 V and a rated output current of 10 A as an example.

A load resistance (RL) of 8 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 8 Ω is greater than 6 Ω (RL > Rc), the operation mode is CV. If you want to increase the voltage in CV mode, the voltage can be increased up to the voltage defined by the following equation: Vs = Is × RL. Substituting the values, we obtain Vs = 5A × 8 Ω = 40 V. If you try to increase the voltage above this point, the crossover point is reached, and the operation mode automatically switches to CC mode. To maintain CV mode, increase the current limit.

Next a load resistance (RL) of 5 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 5 Ω is less than 6 Ω (RL < Rc), the operation mode is CC. If you want to increase the current in CC mode, the current can be increased up to the current defined by the following equation: Is = Vs/RL. Substituting the values, we obtain Is = 30 V/5 Ω = 6 A. If you try to increase the current above this point, the crossover point is reached, and the operation mode automatically switches to CV mode. To maintain CC mode, increase the voltage limit.

3.4 Using the PAT as a CV or CC Power Supply (Setting the Output Voltage and Output Current)

When using the PAT as a constant voltage power supply, the preset current is the limit that can flow through the load.

When using the PAT as a constant current power supply, the preset voltage is the limit that can be applied to the load.

If the specified limit is reached, the operation mode automatically switches. If the operation mode switches, the CV LED or CC LED changes to indicate the switch.

1. Turn the POWER switch off.
2. Connect the load to the output terminal.
3. Turn the POWER switch on.

   If the OUTPUT LED on the display is illuminated, press the OUTPUT switch to turn the output off.
4. Check that the SET switch is illuminated.

   If it is not, press the SET switch so that you can set the voltage and current.
5. Turn the VOLTAGE knob to set the voltage.
6. Turn the CURRENT knob to set the current.
7. Press the OUTPUT switch.

   The OUTPUT LED on the display illuminates, and the voltage and current are delivered to the output terminal.
   The CV LED illuminates when the PAT is operating as a constant voltage power supply.
   The CC LED illuminates when the PAT is operating as a constant current power supply.

You can set the voltage and current by carrying out step 5 and step 6 while checking the actual output voltage or current with the output turned on.

See p. 3-19

You can only use the CONFIG settings to set the output-on startup state (CF32: prioritize CV or CC) .

Fine adjustment function

This function increases the resolution of the VOLTAGE and CURRENT knobs. By turning the VOLTAGE or CURRENT knob while holding down the SHIFT key, you can set the value using finer resolution.

The display resolution of the preset voltage and preset current does not change even if you use the fine adjustment function. Therefore, the displayed value may not change even if you turn the knob. The display changes when the amount of change reaches the minimum displayed digit of the preset voltage or current.

3.5 Protection Functions and Alarms

The PAT is equipped with the following protection function.

- Overvoltage protection (OVP)
- Overcurrent protection (OCP)
- Overheat protection (OHP)
- Overheat protection of the bleeder circuit (BOHP)
- Fan failure protection (FAN)
- Incorrect sensing connection protection (SENSE)
- Input open-phase protection (PHASE)
- Shut down (SD)

Alarm occurrence and release

Alarm occurrence

When a protection function activates, the PAT behaves as follows:

- The output turns off.

  For the overvoltage protection (OVP), overcurrent protection (OCP), and shutdown (SD), you can select breaker trip in the CONFIG settings.

See p. 3-19

- The ALARM LED on the front panel display illuminates, then the cause of alarm occurrence and the current measuring value displays alternately.

  When the breaker trip is selected in overvoltage protection (OVP) or overcurrent protection (OCP) or shutdown (SD), the front panel display shows the characters indicated as power off respectively for about 10 to 15 seconds.

See p. 3-10 to p. 3-13

- The ALARM signal is output from pin 5 of the J1 connector.

  The ALARM signal is delivered 10 to 15 seconds even if the breaker is tripped.

- The breaker trips (only on 400 V input models).

  If the overheat protection (OHP) activates, the breaker trips. The ALARM LED illuminates, and the PAT shows the OHP power-off display tor 10 to 15 seconds.

■ Verifying the cause of alarm occurrence

When the “cause of alarm occurrence” and the “present measuring value” displays alternately, you can change the status of display by pressing the switch specified as follows. It is helpful to verify the cause of alarm occurrence. Note that the displayed setting value can not be changed.

See p. 3-16

CONFIG switch	Displays “the cause of alarm occurrence” and “the parameter number of alarm cause display (CF01).”
SET switch	Displays “the cause of alarm occurrence” and “the present setting value.”
OVP•OCP switch	Displays “the cause of alarm occurrence” and “the setting value of OVP/OCP trip point.”

Releasing the alarm

■ When the breaker trips (when the POWER switch turns off)

After eliminating the cause of the alarm occurrence, turn on the POWER switch.

■ When the output turns off

Turn off the POWER switch, eliminate the cause the alarm occurrence, and then turn the POWER switch back on.

If you cannot clear the alarm even when all of the causes of the alarm occurrence are eliminated, the PAT may have malfunctioned. If this happens, stop using the PAT and contact your Kikusui agent or distributor.

The cause of the alarm occurrences are described in the protection functions.

3.5.1 Overvoltage protection (OVP) and overcurrent protection (OCP)

The overvoltage protection (OVP) and overcurrent protection (OCP) functions activate under the following conditions.

■ Conditions in which the OVP is activated

- When the output terminal voltage exceeds the specified voltage (OVP trip point).
- When the sensing wire comes loose.
- When there is a problem with the PAT.

■ Conditions in which the OCP is activated

- When the output current exceeds the specified current (OCP trip point).
- When there is a problem with the PAT.

The user must set appropriate values for the OVP and OCP trip points. Be sure to first set the OVP and OCP trip points to comply with the load immediately after installing the PAT or changing the load.

Breaker trip function when the OVP or OCP is activated

See p. 3-19

You can select whether to trip the breaker (CF28: ON/OFF) when the OVP or OCP function activates.

OVP and OCP trip point settings

The OVP operates on the output terminal voltage. If you want to activate the function on the voltage across the load, set the OVP trip point by considering the voltage drop in the load cable.

1 Press the OVP•OCP switch.

The OVP•OCP switch LED illuminates, and the specified OVP/OCP trip point is shown on the display.

See p. 8-8

2 While viewing the panel display, turn the VOLTAGE knob to set the OVP trip point or the CURRENT knob to set the OCP trip point.

If the voltage setting is limited in the CONFIG settings (CF29: ON), the OVP trip point cannot be set lower than the present preset output voltage.

If the current setting is limited in the CONFIG settings (CF30: ON), the OCP trip point cannot be set lower than the present preset output current.

Setting limit function

The PAT allows limits to be placed on the voltage and current settings through CONFIG settings so that the overvoltage protection (OVP trip point) and the overcurrent protection (OCP trip point) settings are not exceeded.

This function prevents the output from being turned off when you accidentally set the voltage or current to a value exceeding the OVP or OCP when the output is on.

If you select to limit the voltage setting (CF29: ON), the output voltage can no longer be set to a value to approximately 95% of the OVP trip point. In addition, the OVP trip point can no longer be set to a value less than the preset output voltage.

If you select to limit the current setting (CF30: ON), the output current can no longer be set to a value to approximately 95% of the OCP trip point. In addition, the OCP trip point can no longer be set to a value less than the preset output current.

Checking the OVP or OCP operation

The OVP or OCP is a function for protecting the load. Once you set the OVP or OCP trip point, check that the OVP or OCP works before you connect the load by carrying out the procedure below.

If the voltage limit setting is enabled in the CONFIG settings (CF29: ON), the output voltage cannot be set higher than the OVP trip point. Thus, you will not be able to check the OVP operation.

If the current setting limit is enabled in the CONFIG settings (CF30: ON), the output current cannot be set higher than the OCP trip point. Thus, you will not be able to check the OCP operation.

1 Check that the OUTPUT LED on the display is not illuminated.

2 Set the output voltage to a value less than the OVP trip point.

3 Press the OUTPUT switch to turn the output on.

The OUTPUT LED illuminates.

4 Turn the VOLTAGE knob slowly clockwise.

When the setting value of output voltage exceeds OVP trip point, the ALARM LED on the front panel display illuminates and either of the POWER switch or the output will be turned off (Depending on the CONFIG settings).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the overvoltage protection (OVP) power-off display will be displayed for about 10 to 15 seconds. When the output is turned off, OVP function display and the measuring value are displayed alternately and the ALARM LED continues to be illuminated.

Fig.3-8 Overvoltage protection (OVP) alarm display

Fig.3-9 Overvoltage protection (OVP) power-off display

5 Check that the POWER switch is turned off.

Make sure that the POWER switch is in "off" position.

6 Short the output terminal.

7 Turn the POWER switch on again.

8 Check that the OUTPUT LED on the display is not illuminated.

9 Set the output current to a value less than the OCP trip point.

10 Press the OUTPUT switch to turn the output on.

The OUTPUT LED illuminates.

11 Turn the CURRENT knob slowly clockwise.

When the setting value of output current exceeds OCP trip point, the ALARM LED on the front panel display illuminates and either of the POWER switch or the output will be turned off (Depending on the CONFIG settings).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the overcurrent protection (OCP) power-off display will be displayed for about 10 to 15 seconds. When the output is turned off, OCP function display and the measuring value are displayed alternately and the ALARM LED continues to be illuminated.

Fig.3-10 Overcurrent protection (OCP) alarm display

Fig.3-11 Overcurrent protection (OCP) power-off display

If you do not change the preset output, the OVP or OCP will activate again.

3.5.2 Other Protection Functions

Overheat protection (OHP)
Overheat protection of the bleeder circuit (BOHP)

This function is activated when the internal temperature of the PAT rises abnormally, and the output turns off (the breaker trips for 400 V input models when overheat protection (OHP) activates).
It protects the PAT from the following conditions.

- When the PAT is used in an environment exceeding the operation temperature range temperaaa
- When the PAT is used with the intake or exhaust port blocked

If you turn the POWER switch back on without correcting the condition that caused the OHP or BOHP, the OHP or BOHP will be activated again.

After the OHP activates on a 400 V input model, it takes between 30 minutes and 1 hour for the internal temperature to decrease. Allow sufficient time for the PAT to cool down before turning the POWER switch on.

Fig.3-12 Overheat protection (OHP) alarm display

Fig.3-13 Overheat protection (OHP) power-off display (only on 400 V input model)

Fig.3-14 Overheat protection alarm display for the bleeder circuit (BOHP)

Fan failure protection (FAN)

This function is activated when the fan rotation drops to an abnormal level, and the output turns off.

Fig.3-15 Alarm display of fan failure protection (FAN)

Incorrect sensing connection protection (SENSE)

This function is activated when the remote sensing wires are connected with the polarity reversed of + (pos.) and - (neg.), and the output turns off.

Fig.3-16 Alarm display of incorrect sensing connection protection (SENSE)

Input open-phase protection (PHASE)

Three-phase input power supply may operate normally even when one of the phase is open. However, operating the PAT in an open-phase condition puts stress on the PAT and may cause a malfunction.

To prevent a malfunction from abnormal input, this function is activated when one or more phase is open among the three-phase input, and the turns off.

Fig.3-17 Alarm display of input open-phase protection (PHASE)

Shutdown (SD)

See p. 4-19

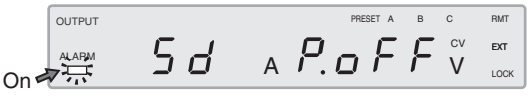
Shutdown is not activated as a result of the PAT detecting an error. It is a function used to turn off the output by applying an external signal to the J1 connector on the rear panel when an abnormal condition occurs.

See p. 3-19

You can select whether to trip the breaker (CF27: ON/OFF) when the shutdown signal is applied.

Not set to trip the breaker (OFF)

Fig.3-18 Alarm display of the shutdown (SD)



Set to trip the breaker (ON)

Fig.3-19 Shutdown power-off display (SD)

3.6 CONFIG Settings

CONFIG settings are used to set the system configuration of the PAT. You can set or display the parameters in Table 3-1 in the CONFIG settings. On the top panel of the PAT is a label that indicates a list of CONFIG parameters and settings.

Table 3-1 CONFIG parameters

Parameter number	Indication on the top panel label	Description of the setting or display
CF01	ALARM	Alarm cause display
CF02	REMOTE SENSING	Remote sensing status display
CF10	ON DELAY	Output on delay setting
CF11	OFF DELAY	Output off delay setting
CF12	PRESET KEYLOCK	Preset recall setting while locked
CF13	ERR TRACE	Communication error display setting*1
CF20	CV CONTROL	CV control source setting*2
CF21	CC CONTROL	CC control source setting*2
CF22	EXT OUT CTRL	External control logic setting of the output on/off*2
CF23	PWR ON/OFF STATUS	Status signal setting of the power on/off*1
CF24	PARALLEL	Setting the number of units in Master-Slave Parallel Operation*2
CF25	POWER ON OUTPUT	Output status setting at power-on
CF26	MASTER/SLAVE	Master-slave parallel operation setting*1, *2
CF27	BREAKER TRIP (SD)	Breaker trip setting when the shutdown signal is applied*1
CF28	BREAKER TRIP	Breaker trip setting when the OVP or OCP is activated*1
CF29	V SETTING LIMIT	Voltage limit setting*2
CF30	I SETTING LIMIT	Current limit setting*2
CF32	START UP	Output-on startup state setting *2
CF40	BAUDRATE	RS232C data rate setting*1
CF41	DATABITS	RS232C data length setting*1
CF42	STOPBITS	RS232C stop bit setting*1
CF43	FLOW	RS232C flow control setting*1
CF50	VERSION	Interface version display*3
CF51	GPIB ADDRESS	GPIB address setting*1, *4
CF52	VENDOR ID	Vendor ID display*5
CF53	PRODUCT ID	Product ID display*5
CF54	ADDON I/F	Remote interface setting*1, *3
CF55	DHCP CLIENT	DHCP setting*6
CF56	AUTO IP ADDRESS	AUTO IP address setting*6
CF57	IP ADDRESS (1)	IP address display (1)*6
CF58	IP ADDRESS (2)	IP address display (2)*6
CF59	IP ADDRESS (3)	IP address display (3)*6
CF60	IP ADDRESS (4)	IP address display (4)*6
CF61	LAN STATUS	LAN status display*6

*1. The setting is possible even when the product is used as a slave unit.
*2. Cannot be set when the output is on.
*3. Only when the factory option GPIB, USB or LAN interface is installed.
*4. Only when the factory option GPIB interface is installed.
*5. Only when the factory option USB interface is installed.
*6. Only when the factory option LAN interface is installed.

Setup and view procedure of CONFIG parameters

CF01, CF02, CF50, CF52, CF53 and CF57 to CF61 are parameters only for viewing the status. You cannot set them.

CF50 to CF61 appear only when the option board is installed. The display of the setting varies depending on the interface option.

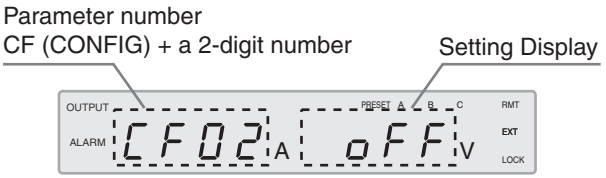


Fig.3-20 CONFIG parameter display example

1 Press the CONFIG switch.

The switch LED illuminates. The ammeter displays the parameter number, and the voltmeter displays the present setting.

2 Turn the CURRENT knob to select the parameter number.

3 Turn the VOLTAGE knob to change the setting.

If you select a new setting, it blinks.

When the setting is blinking, the new setting is not entered until you press a switch. If you do not want to change the setting, turn the VOLTAGE knob and select the setting that illuminates (not blinking) to return to the original setting.

You cannot set CF20, CF21, CF22, CF24, CF26, CF29, and CF30 when the output is on. The present setting is displayed, but it cannot be changed even if you turn the VOLTAGE knob.

4 To set or display other parameters, repeat step 2 and step 3 .
To exit from the CONFIG settings, proceed to step 5 .

5 Press any of the switch from SET, OVP•OCP, CONFIG or OUTPUT switch. If it is set to the slave unit, press CONFIG switch.

It will exit from the CONFIG setting to reflect the setting conditions.

Even when the POWER switch is turned off, the setting description will be reflected.

CONFIG parameter details

CF01 Alarm cause display

Displays the cause of the alarm occurrence (while the ALARM LED is illuminated). If there are multiple causes, the sum of each cause is displayed.

Display	Description
0	Not an alarm condition (ALARM LED is off)
1	Overvoltage protection (OVP)
2	Overcurrent protection (OCP)
4	overheat protection (OHP)
8	Input open-phase protection (PHASE)
16	Incorrect sensing connection protection (SENSE)
32	Fan failure protection (FAN)
64	Shut down (SD)
128	Overheat protection of the bleeder circuit (BOHP)

CF02 Remote sensing status display

See p. 3-25

Displays the state of the sensing switch on the rear panel.

Display	Description
oFF	Remote sensing is off
on	Remote sensing is on

CF10 Output on delay setting

See p. 3-4

Set the delay from the time the OUTPUT switch is pressed until the output turns on.

When exiting from the CONFIG settings by the OUTPUT switch, the output on delay function is activated at the some time for which setting conditions were set by the output on delay settings.

Settings	Description
oFF	No delay (factory default)
0.1 to 10.0	Output on delay. Unit: s, resolution: 0.1

CF11 Output off delay setting

See p. 3-4

Set the delay from the time the OUTPUT switch is pressed until the output turns off.

When exiting from the CONFIG settings by the OUTPUT switch, the output off delay function is activated at the some time for which setting conditions were set by the output off delay settings.

Settings	Description
oFF	No delay (factory default)
0.1 to 10.0	Output off delay. Unit: s, resolution: 0.1

CF12 Preset recall setting while locked

See p. 3-24

Sets whether preset memory values can be recalled even when the lock function is enabled.

Settings	Description
0	Able to recall preset memory values in the locked condition
1	Unable to recall preset memory values in the locked condition (factory default)

CF13 Communication error display setting

Sets whether to display communication errors by performing a device trace. Displays the error number when the PAT is in remote mode, and there is at least one error in the SCPI error queue. The setting is possible even when the product is used as a slave unit.

Fig.3-21 Error display example (Err-100 example)

Settings	Description
oFF	Not display communication errors (factory default)
on	Display communication errors

CF20 CV control source setting

See p. 4-9, p. 4-11

Selects the constant voltage control mode. Cannot be set when the output is on.

Settings	Description
0	Panel control (factory default)
1	External voltage control EXT-V
2	External resistance control EXT-R 10 kΩ → MAX OUT
3	External resistance control EXT-R 10 kΩ → 0 OUT (FAIL SAFE)
4	External voltage control EXT-V (FAST)

CF21 CC control source setting

See p. 4-13, p. 4-15

Select the constant current control mode. Cannot be set when the output is on.

Settings	Description
0	Panel control (factory default)
1	External voltage control EXT-V
2	External resistance control EXT-R 10 kΩ → MAX OUT
3	External resistance control EXT-R 10 kΩ → 0 OUT (FAIL SAFE)
4	External voltage control EXT-V (FAST)

CF22 External control logic setting of the output on/off

See p. 4-17

Sets the logic used to control the output on/off using an external contact (J1 connector). Cannot be set when the output is on.

Select “H” when not controlling the output on/off with an external contact.

Settings	Description
H	Turn the output on with a high signal (factory default)
L	Turn the output on with a low signal

CF23 Status signal setting of the power on/off

See p. 4-22

Sets whether to output a low level signal while the power is on or off when monitoring the power on/off status externally (through the J1 connector). The setting is possible even when the product is used as a slave unit.

Settings	Description
0	Output a low level signal while the power is on (factory default)
1	Output a low level signal for 10 to 15 s when the power is off

CF24 Setting the number of units in Master-Slave Parallel Operation

See p. 5-2

Sets the total number of units which consists of the master unit and the slave units under the Master-Slave Parallel Operation. However, it can not be set when the output is turned on.

On models other than the PAT850-9.4T

Settings	Description
1 to 5	Setting the total number of units 1 (factory default) to 5

On the PAT850-9.4T

Settings	Description
1	1 unit (factory default)
2	2 units

CF25 Output status setting at power-on

See p. 3-3

Sets the output state when the POWER switch is turned on. This setting is invalid when the output is turned off using an external contact.

Settings	Description
oFF	Output is off at power-on (factory default)
on	Output is on at power-on

CF26 Master-Slave parallel operation setting

See p. 5-7

Sets the PAT condition during master-slave parallel operation. Cannot be set when the output is on. The setting is possible even when the product is used as a slave unit.

Settings	Description
0	Master unit or independent operation (factory default)
1	Slave unit

CF27 Breaker trip setting when the shutdown signal is applied

See p. 3-13

Sets whether to trip the breaker (turn the POWER switch off) when an external shutdown (SD) signal is applied. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Not trip (turn the output off) (factory default)
on	Trip (turn the POWER switch off)

CF28 Breaker trip setting when the OVP or OCP is activated

See p. 3-9

Sets whether to trip the breaker (turn the POWER switch off) when the overvoltage protection (OVP) or overcurrent protection (OCP) is activated. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Not trip (turn the output off) (factory default)
on	Trip (turn the POWER switch off)

CF29 Voltage limit setting

See p. 3-10

Sets whether to limit the output voltage setting so that it does not exceed the overvoltage protection setting (to approximately 95% of the OVP trip point) Cannot be set when the output is on.

Settings	Description
oFF	Not limit (factory default)
on	Limit

CF30 Current limit setting

See p. 3-10

Sets whether to limit the output current setting so that it does not exceed the overcurrent protection setting (to approximately 95% of the OCP trip point) Cannot be set when the output is on.

Settings	Description
oFF	Not limit (factory default)
on	Limit

CF32 Output-on startup state setting

You can set the state that the PAT starts up in when the output state at power-on is set to on. This cannot be set when the output is on.

When you select to prioritize CC, set CV to 10 % or more of the rated value. A current that is greater than the CC setting may flow through the load when the output is turned on. Depending on the state of the connected load, the PAT may not start with the settings that you have selected.

Settings	Description
CV	CV (constant voltage) is prioritized (factory default)
CC	CC (constant current) is prioritized

CF40 RS232C data rate setting

See p. 6-3

Sets the baud rate of RS232C. The setting is possible even when the product is used as a slave unit.

Settings	Description
1.2	1200 bps
2.4	2400 bps
4.8	4800 bps
9.6	9600 bps
19.2	19200 bps (factory default)
38.4	38400 bps

CF41 RS232C data length setting

See p. 6-3

Sets the RS232C data length. The setting is possible even when the product is used as a slave unit.

Settings	Description
7bIt	7 bits
8bIt	8 bits (factory default)

CF42 RS232C stop bit setting

See p. 6-3

Sets the RS232C stop bit. The setting is possible even when the product is used as a slave unit.

Settings	Description
1bIt	1 bit (factory default)
2bIt	2 bits

CF43 RS232C flow control setting

See p. 6-3

Sets whether to perform flow control of RS232C. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Disable flow control
on	Enable flow control (factory default)

CF50 Interface version display

Displays the version of the factory option interface. Displayed only when the interface is installed.

Display	Description
1.00	Interface version

See p. 6-5

CF51 GPIB address setting

Sets the GPIB address. The settings are displayed only when the factory option GPIB interface is installed. The setting is possible even when the product is used as a slave unit.

Settings	Description
1 to 30	Specify the address between 1 (factory default) and 30

CF52 Vendor ID display

Displays the vendor ID. Displayed only when the factory option USB interface is installed.

Display	Description
0b3E	0x0B3E

CF53 Product ID display

Displays the product ID. Displayed only when the factory option USB interface is installed.

Display	Description
100E	0x100E

CF54 Remote interface setting

Sets the remote interface that is to be used. Displayed only when the factory option interface is installed. The displayed settings vary depending on the installed interface option. The setting is possible even when the product is used as a slave unit.
The installed interface becomes the default.

When the GPIB interface is installed

Settings	Description
232C	Use RS232C for the remote interface
GPib	Use GPIB for the remote interface (factory default)

When the USB interface is installed

Settings	Description
232C	Use RS232C for the remote interface
uSb	Use USB for the remote interface (factory default)

When the LAN interface is installed

Settings	Description
232C	Use RS232C for the remote interface
uSb	Use LAN for the remote interface (factory default)

See p. 6-5

CF55 DHCP setting

Select whether or not to obtain an IP address from a DHCP server. Displayed only when the factory option LAN interface is installed.
When the fixed IP address is used, set to turning off.

Settings	Description
oFF	Not to use the DHCP server
on	Use the DHCP server (factory default)

See p. 6-7

CF56 AUTO IP address setting

When the DHCP is not used or not enable to be used, set whether to fix the IP address automatically. The IP address assigned by the AUTO IP is 169.254.x.x (x is 0 to 254). Displayed only when the factory option LAN interface is installed.
When the fixed IP address is used, set to turning off.

Settings	Description
oFF	Not to use the AUTO IP function
on	Use the AUTO IP function (factory default)

CF57 to CF60 IP address display

Confirm the setting IP address. Displayed only when the factory option LAN interface is installed.

The IP address is just displayed-it cannot be set from the panel. To set a fixed IP address, access the PAT through a Web browser.

When you access the PAT through a Web browser, do so under conditions in which a DHCP server or AUTO IP can be used.

For information about the PAT-T series from a Web browser, see the accompanying CD-ROM.

Parameter number	Display	Description
CF57	0 to 255	Display the 1st number of the IP address
CF58	0 to 255	Display the 2nd number of the IP address
CF59	0 to 255	Display the 3rd number of the IP address
CF60	0 to 255	Display the 4th number of the IP address

CF61 LAN status display

Display the status of the LAN interface. Displayed only when the factory option LAN interface is installed.

Display	Description
Stby	Stand by state (the LAN can not be used)
nFLt	No fault state (the LAN is functioned properly)
FLt	Fault state (the LAN is not functioned properly)
LAn	Display identifying the LAN

3.7 Preset Memory Function

The PAT has a function that stores up to three combinations of voltage setting and current setting. You can store a combination by selecting memory switch A (PRESET A), B (PRESET B), or C (PRESET C).
RECALL switches allow you to recall any of the three preset memory values.

Storing the preset memory values

1. Press the SET switch.
   The SET switch LED illuminates, and the specified voltage and current are shown on the panel.
2. While viewing the panel display, turn the VOLTAGE knob to set the voltage preset memory value, the CURRENT knob to set the current preset memory value.
3. Press the STORE switch while holding down the SHIFT switch.
   PRESET A, B, and C LEDs blink in the display.
4. Press any memory switch (A, B or C) to be stored, and save the value of preset memory.
   The selected preset memory (A, B or C) illuminates on the display.

You can save preset memory values by carrying out step 3 and step 4 with the output turned on while displaying the measured values (SET switch turned off). After saving the preset memory values, press the SET switch to check them.

Recalling the preset memory values

1. Press the SET switch.
   The SET switch LED illuminates, and the specified voltage and current are shown on the panel.
2. While holding down the SHIFT switch, press the RECALL switch in which the preset memory values you want to recall is stored.
   The LED of the recalled preset memory values (PRESET A, B, or C) illuminates.
   If no load is connected, it takes a long time for the output voltage to rise.

You can recall preset memory values by carrying out step 2 above with the output turned on while displaying the measured values (SET switch turned off). If the recalled memory value exceeds the OVP or OCP trip point, the OVP or OCP function trips.

If the voltage or current setting is limited in the CONFIG settings (CF29 or CF30: ON) and the recalled preset memory values exceed the OVP or OCP trip point, the output setting is limited to approximately 95 % of the OVP or OCP trip point. Then, PRESET A, B, or C LED corresponding to the preset memory that was recalled illuminates for approximately 1 second and turns off.

See p. 3-17

You can set CF12 to 0 CONFIG parameter to enable preset memory values to be recalled even in the locked condition.

3.8 Lock Function

The PAT has a lock function that prevents the settings from being changed inadvertently.

The following operations are disabled in the locked condition (the LOCK LED on the display is illuminated).

- Setting of the current and voltage.
- Setting of the OVP and OCP.
- Setting of the CONFIG parameters.
- Saving and recalling of preset memories.

See p. 3-17

You can set CONFIG parameter CF12 to 0 to enable preset memory values to be recalled even in the locked condition.

Fig.3-22 Panel display example in the locked condition

■ Setting

1. Set all the required parameters such as the output voltage and output current.
2. Press the LOCK (SHIFT+LOCAL) switch.

   The LOCK LED on the display illuminates, and the lock is enabled.

■ Release

To release the lock function, hold down LOCK (SHIFT+LOCAL) switch until the LOCK LED on the display turns off.

3.9 Switching from Remote to Local Mode

When the PAT is operating under remote control, the RMT LED on the display illuminates.

Fig.3-23 Panel display example in remote mode

To switch from the remote mode to the local mode (panel operation) from the panel, press the LOCAL switch.

If the local lockout (llo) is specified in remote mode, the PAT does not switch to local mode (panel operation) even when the LOCAL switch is pressed. Transmist IEEE488.1 ren or SYST:LOC to clear the local lockout (llo).

3.10 Remote Sensing Function

The remote sensing function is used to reduce the influence of voltage drops due to the load cable resistance and stabilize the output voltage across the load.

See p. 2-5

The remote sensing function of the PAT can compensate up to approximately 0.6 V for a single line. Select a load cable with sufficient current capacity so that the voltage drop in the load cable does not exceed the compensation voltage. When the remote sensing is performed, apply the voltage of sensing point (at the load terminal) which does not exceed the rated output voltage. When the remote sensing is performed at near to the maximum output voltage, the output is limited at the maximum voltage (105 % of the rated output voltage).

To perform remote sensing, an electrolytic capacitor may be required at the sensing point (load terminal).

Connection of the sensing cable

⚠WARNING Possible electric shock or damage to the internal circuitry.

- **Never wire the cable to the sensing terminals while the POWER switch is turned on.**
- **For sensing cables, use cables with a higher voltage rating than the isolation voltage of the PAT. Protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
- **The sensing terminals are at approximately the same potential as the - (neg.) output terminal of the PAT. Insert the wire so that the wire scraps protruding from the sensing terminals do not come in contact with the chassis. Also, insert wires to the terminals so that the stripped sections do not protrude from the terminals.**

If the sensing wires come loose, the output voltage across the load cannot be stabilized and may cause excessive voltage to be applied to the load. If an appropriate OVP trip point is set, the OVP trips and prevents excessive voltage output.

After you are done using the remote sensing function, remove the sensing wires, and be sure to turn off remote sensing using the sensing switch.

See p. 3-16

You can check the sensing switch status using the CONFIG settings (CF02).

■ Notes when connecting the sensing cable

Use AWG24 wires to connect to the sensing terminals. Remove 10 mm of the wire covering.

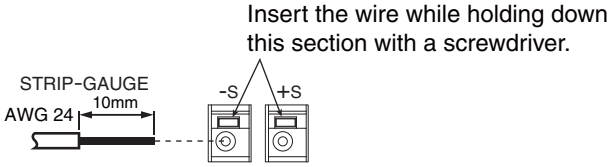


Fig.3-24 Connection to the sensing terminal

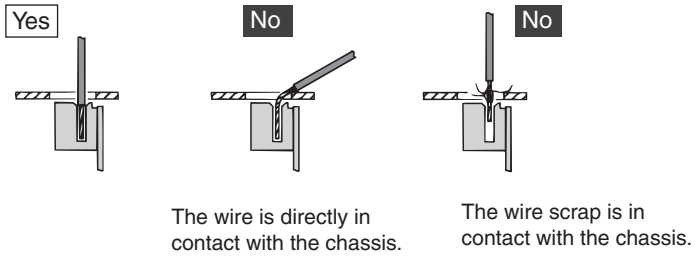


Fig.3-25 Appropriate and inappropriate connections

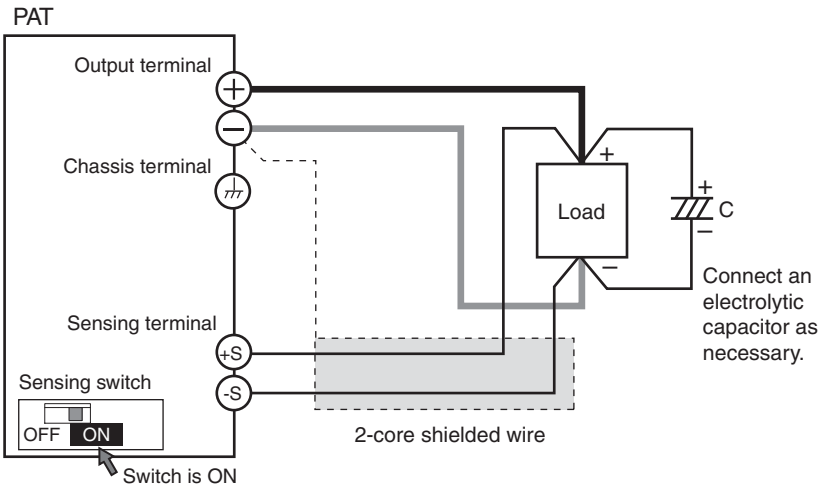


Fig.3-26 Remote sensing connection

1 Turn the POWER switch off.

2 Turn on the sensing switch on the rear panel.

3 As shown in Fig.3-26, connect the sensing cable between the sensing terminal and the load terminal.

To decrease output ripple voltages resulting from inductive effects, use a two-core shielded wire for the sensing wires. Connect the shield to the − (neg.) terminal.
If you cannot use shielded wires, twist the + (pos.) and − (neg.) wires thoroughly.
Remove the covering from the sensing wires appropriately before connecting them.

See Fig.3-24

■ Electrolytic capacitor connected at the load end

If the inductance in the wire is large, the following symptoms may appear. Twisting the load wires reduces the inductance, thereby stabilizing the output. However, if this does not solve the problem, connect an electrolytic capacitor at the load end.

- Oscillation

  If the wiring to a load is long, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation.

- Fluctuating output

  If the load current changes suddenly to pulse form, the output voltage may increase due to the effects from the inductance component of the wiring.

Electrolytic capacitor required

Capacitance: 0.1 µF to several-hundred µF

Withstand voltage: Greater than or equal to 120 % of the rated output voltage of the PAT

■ When inserting a mechanical switch between the PAT and the load

If you are using a mechanical switch that is inserted between the PAT and the load to turn on/off the connection between them, insert a switch also in the sensing wire as shown in Fig.3-27 and turn on/off the load wire and the sensing wire simultaneously. Be sure to turn off the OUTPUT switch or POWER switch before turning on/off the mechanical switch.

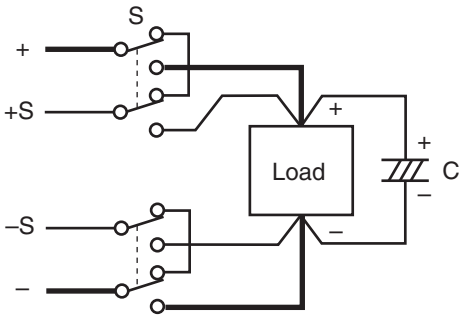


Fig.3-27 On/Off using the mechanical switch

3.11 Factory Default Settings

Turning ON the POWER switch while holding down the SHIFT switch initializes the settings to factory default. Carry out this operation when you want to reset all settings to factory default values. The factory default settings are given in the tables below.

Table 3-2 Factory dfault settings of basic parameters

Basic Item	Setting
Output voltage	0 V
Output current	105 % of the rated output current
Overvoltage protection (OVP)	111.5 % of the rated output voltage
Overcurrent protection (OCP)	111.5 % of the rated output current
Preset memory values A/B/C	Voltage: 0 V, Current: 105 % of the rated output current

Table 3-3 Factory default settings of the CONFIG parameters

Parameter number	Operating condition (CONFIG parameter)	Setting
CF10	Output on delay setting	OFF
CF11	Output off delay setting	OFF
CF12	Preset recall setting while locked	1 (unable to recall)
CF13	Communication error display setting	OFF (not displayed)
CF20	CV control source setting	0 (panel control)
CF21	CC control source setting	0 (panel control)
CF22	External control logic setting of the output on/off	H
CF23	Status signal setting of the power on/off	0 (POWER ON STATUS)
CF24	Setting the number of units in Master-Slave Parallel Operation	1 (1 unit)
CF25	Output status setting at power-on	OFF (output off at power-on)
CF26	Master-slave parallel setting	0 (master unit)
CF27	Breaker trip setting when the shutdown signal is applied	OFF (not trip)
CF28	Breaker trip setting when the OVP or OCP is activated	OFF (not trip)
CF29	Voltage limit setting	OFF (not limit)
CF30	Current limit setting	OFF (not limit)
CF32	Output-on startup state setting	CV (CV is prioritized)
CF40	RS232C data rate setting	19.2 (kbit/s)
CF41	RS232C data length setting	8 bit
CF42	RS232C stop bit setting	1 bit
CF43	RS232C flow control setting	ON (Xon/off flow control)
CF51*1	GPIB address setting	1
CF52*2	Remote interface setting	GPIB, USB or LAN*3
CF55*4	DHCP setting	ON (Use the DHCP server)
CF56*4	AUTO IP address setting	ON (Use the AUTO IP function)

*1. Only when the factory option GPIB is installed.
*2. Only when the factory option GPIB, USB or LAN interface is installed.
*3. Interface installed by factory option.
*4. Only when the factory option LAN interface is installed.

4

External Control

This chapter describes external analog control and remote monitoring using the J1 connector.

4.1 Overview of External Control

The J1 connector on the rear panel of the PAT can be used to perform external control listed below.

- Output voltage control

  Control using external voltage or external resistance
- Output current control

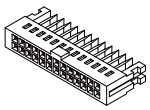
  Control using external voltage or external resistance
- Output on/off using external contact
- Shutdown using external contact (turn off the output or POWER switch)

When the PAT is operating under external control, the EXT LED on the front panel display illuminates.

Fig.4-1 Display example during external control operation

4.2 J1 Connector

At the factory shipment, the protection socket is attached to the J1 connector. Keep this protection socket and be sure to attach when the J1 connector is not used. If the protection socket is damaged or lost, contact Kikusui distributor/agent.



[84-49-0110]

Fig.4-2 Protection socket

⚠WARNING Possible electric shock.

- **The J1 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

A connector kit is provided for connecting the J1 connector. The connector kit consists of connector parts conforming to the MIL standard made by Omron.

The single contact connection tool and contact removal tool are not provided. Please obtain your own tools.

For information on how to obtain the tools and consumable parts, contact your Kikusui agent or distributor.

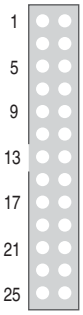
Table 4-1 Connector parts by Omron needed to connect the J1 connectorJ1

Product	Model	Kikusui parts no.	Notes
Single contact connection tool	XY2B-7006	Y2-070-001	Not included.
Contact removal tool	XY2E-0001	Y2-070-002	Not included.
Pin (contact)	XG5W-0031	84-49-0100	Recommended wire size AWG24 (UL-1061).
Socket	XG5M-2632-N	84-49-0160	MIL standard type socket.
Protection cover (semi cover)	XG5S-1301	84-49-0161	–

For details about how to use the products, refer Omron's catalog.

Table 4-2 connector pin arrangement

J1



A position of the pin number that looked at from the panel side.

Pin No.	Signal Name	Description
1	STATUS COM	Common for status signals from pin 3 through 7.*1
2	STATUS COM	Common for status signals from pin 3 through 7.*1
3	PWR ON/OFF STATUS*2	PWR ON STATUS (CF23: 0): Output a low level signal while the power is on. PWR OFF STATUS (CF23: 1): Output a low level signal when the power is off. (open collector output by a photocoupler*3)
4	OUT ON STATUS	On when the output is on (open collector output by a photocoupler*3).
5	ALM STATUS	Turns on when the OVP, OCP, OHP, PHASE, SENSE, FAN, or BOHP is activated or when a shutdown signal is applied (open collector output by a photocoupler).*3
6	CC STATUS	On during CC operation (open collector output by a photocoupler*3).
7	CV STATUS	On during CV operation (open collector output by a photocoupler*3).
8	AUX	Reserved.
9	AUX	Reserved.
10	I SUM IN	Current signal input terminal in Master-Slave Parallel Operation
11	D COM	Digital signal common for pins 12 and 14*1 When the remote sensing is used, connect the cable to the negative electrode (-S) of the sensing input, and when the remote sensing is not used, connect the cable to the negative (-) output (same as pin 13).
12	SHUT DOWN	Shutdown (trips the POWER switch or turns the output off when a low TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ).
13	D COM	Same as pin 11.
14	OUT ON/OFF CONT	Output on/off terminal Turn off when a low (or high) TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ.
15	A COM	Analog signal common for pins 16, 18, 20, and 22.*1 Connected to the negative electrode (-S) of the sensing input when remote sensing is used; connected to - (neg.) output when remote sensing is not used. (Same as pins 17, 19, 21, and 23.)
16	I MON	Output current monitor (Outputs 0 % to 100 % of the rated current using 0 V to 10 V).
17	A COM	Same as pin 15.
18	V MON	Output voltage monitor (Outputs 0 % to 100 % of the rated voltage using 0 V to 10 V).
19	A COM	Same as pin 15.
20	EXT CC CONT	External voltage control of output current (0 % to 100 % of the rated output voltage using 0 V to 10 V) or external resistance control of output current. • 0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ (CF21: 2) • 100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ (CF21: 3)
21	A COM	Same as pin 15.
22	EXT CV CONT	External voltage control of output voltage (0 % to 100 % of the rated output voltage using 0 V to 10 V) or external resistance control of output voltage. • 0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ (CF20: 2) • 100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ (CF20: 3)
23	A COM	Same as pin 15.
24	PRL IN COMP	Correction signal input terminal during master-slave parallel operation.
25	PRL IN-	Negative electrode input terminal during master-slave parallel operation.
26	PRL IN+	Positive electrode input terminal during master-slave parallel operation.

*1. Use the shortest possible wires for the common wires.
*2. Status signal setting of the power on/off (CF23): Either one specified in the CONFIG settings is activated.
*3. Open collector output: Maximum voltage of 30 V and maximum current of 8 mA. It is insulated from the control circuit.

4.3 Output terminal Insulation

Note the following points and insulate the output terminals.

⚠WARNING

- **Possible electric shock. For safety reasons, even if the output terminal is grounded, make sure the insulation capacity of the output terminal (including the sensing terminal) is greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
  If you cannot obtain a cable with sufficient rated voltage, secure adequate withstand voltage by passing the cable through an insulation tube with a withstand voltage greater than the isolation voltage of the PAT.

⚠CAUTION

- The signal wire may burn out. If the PAT is to be controlled through an external voltage (Vext), do not ground it (leave it floating).

The cable and load that are connected to the output terminal (including the sensor terminal) must have an insulation capacity that is greater than the isolation voltage of the PAT with respect to the chassis.
Isolation voltage indicates the maximum allowed voltage that appears across the output terminal of the power supply unit and the protective conductor terminal (chassis terminal).

4.3.1 When the Output terminal Is Not Grounded (Floating)

The output terminal of the PAT is isolated from the protective conductor terminal. By connecting the GND wire of the power cable to the ground terminal of the switchboard, the chassis of the PAT is set to ground potential as shown in Fig.4-3.

Pins 10 through 26 of the J1 connector on the rear panel (for external control and output monitoring) are at approximately the same potential as the - (neg.) output terminal of the PAT. Cables and devices that are connected to these pins must also have an insulation capacity that is greater than or equal the isolation voltage of the PAT.

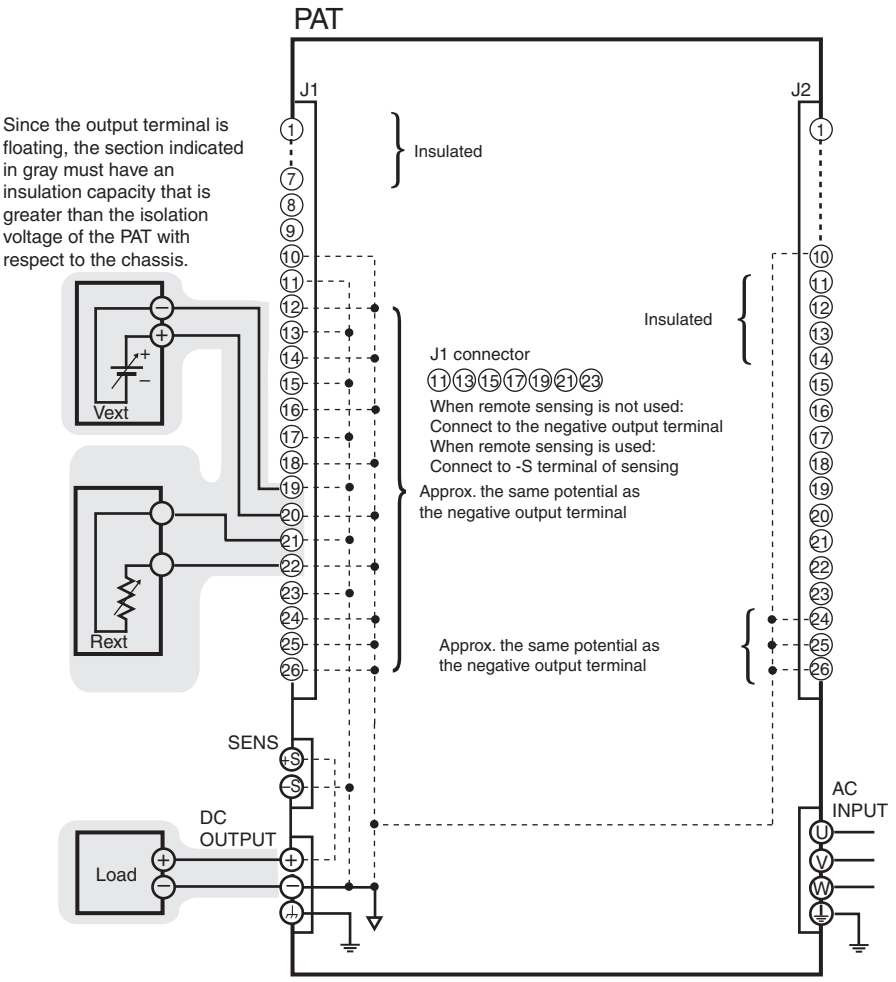

PAT
J1
J2
Since the output terminal is floating, the section indicated in gray must have an insulation capacity that is greater than the isolation voltage of the PAT with respect to the chassis.
Insulated
Insulated
J1 connector
11 13 15 17 19 21 23
When remote sensing is not used:
Connect to the negative output terminal
When remote sensing is used:
Connect to -S terminal of sensing
Approx. the same potential as the negative output terminal
Approx. the same potential as the negative output terminal
Vext
Rext
SENS
+S
-S
DC OUTPUT
Load
AC INPUT
U
V
W

Fig.4-3 When the output terminal is not grounded

4.3.2 When the Output terminal Is Grounded

If the positive output terminal is connected to the chassis terminal, the terminal is at ground potential as shown in Fig.4-4. The cable and load that are connected to the output terminal (including the sensing terminal) will only require an insulation capacity that is greater than the maximum output voltage of the PAT with respect to the chassis. There is no need to provide insulation greater than the isolation voltage of the PAT.

The same holds true when the negative terminal is connected to the chassis terminal. The cable and load require an insulation capacity that is greater than the maximum output voltage of the PAT.

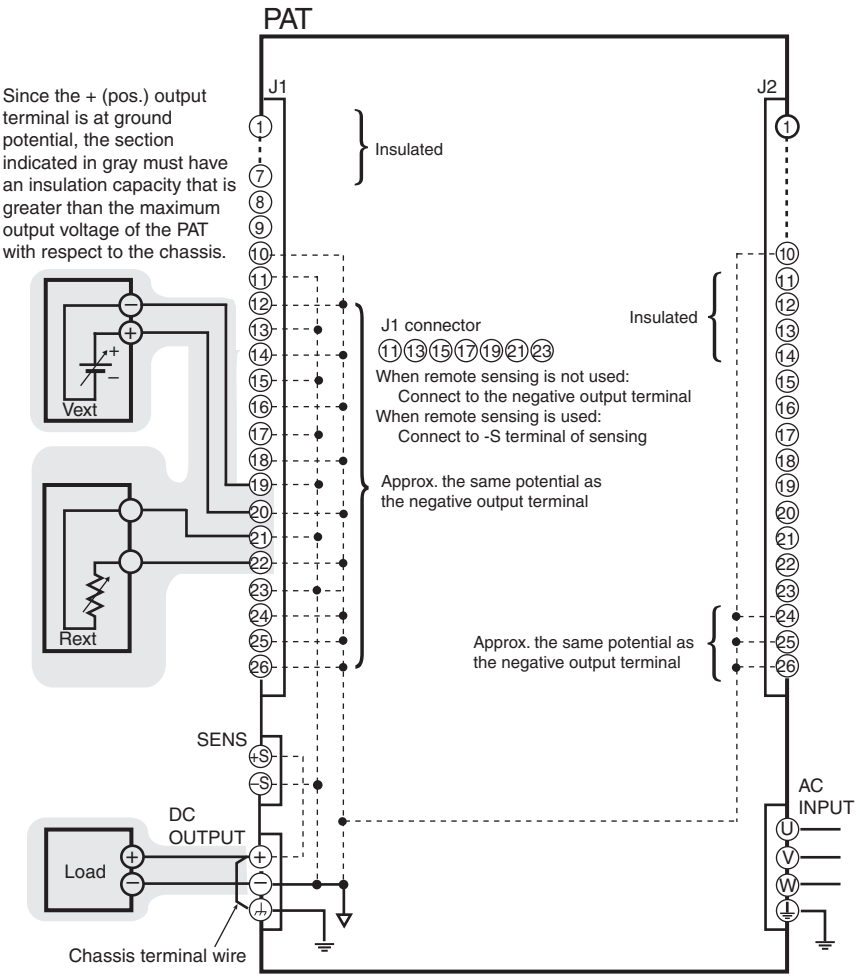

PAT
Since the + (pos.) output terminal is at ground potential, the section indicated in gray must have an insulation capacity that is greater than the maximum output voltage of the PAT with respect to the chassis.
J1
J2
Insulated
J1 connector
11 13 15 17 19 21 23
When remote sensing is not used:
Connect to the negative output terminal
When remote sensing is used:
Connect to -S terminal of sensing
Insulated
Approx. the same potential as the negative output terminal
Approx. the same potential as the negative output terminal
Vext
Rext
SENS
+S
-S
DC OUTPUT
Load
AC INPUT
U
V
W
Chassis terminal wire

Fig.4-4 When the output terminal is grounded

If the external voltage (Vext) output is grounded for the case shown in Fig.4-4, the output is short-circuited (which can cause accidents).

For safety reasons, connect either output terminal to the chassis terminal unless your application requires the output terminal to be floating.

When using the external voltage (Vext)

Connect the wires so that the output is not shorted as shown in Fig.4-5 and Fig.4-6.

⚠CAUTION The signal wire may burn out.

- The signal wire may burn out. Leave the Vext output floating.
- If you are connecting the shield to the Vext side, do not connect the shield to the output terminal of the PAT.

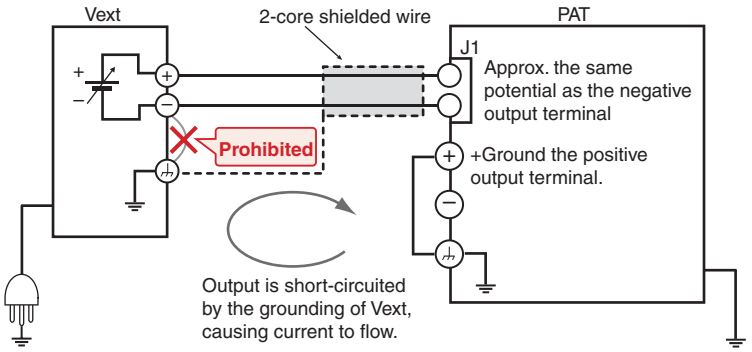

Vext
2-core shielded wire
PAT
J1
Approx. the same potential as the negative output terminal
Prohibited
+Ground the positive output terminal.
Output is short-circuited by the grounding of Vext, causing current to flow.

Fig.4-5 A connection in which the output is short-circuited by the grounding of Vext (example of a prohibited connection)

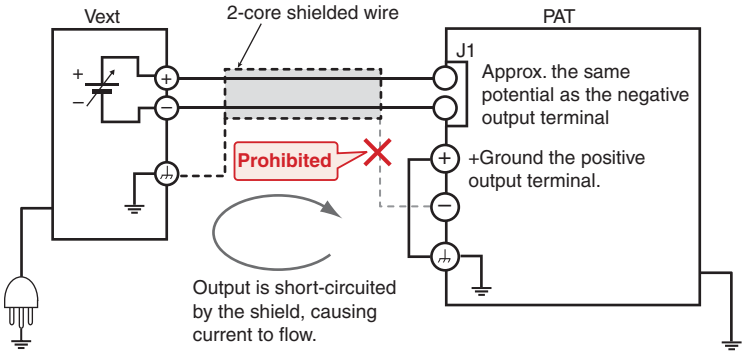


Fig.4-6 A connection in which the output is short-circuited by the shield (example of a prohibited connection)

4.4 Controlling the Output Voltage

This section explains the method used to control the output voltage using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ.

The output voltage will change approximately 5 ms after the value of the applied external voltage or resistance changes.

If no load is connected, it takes a long time for the output voltage to fall.

⚠WARNING Possible electric shock.

- **The insulation of the Vext or Rext and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

4.4.1 External Voltage (Vext) Control

See p. 3-17

To control the output voltage using Vext, set the CV control source in the CONFIG settings to one of the following two modes.

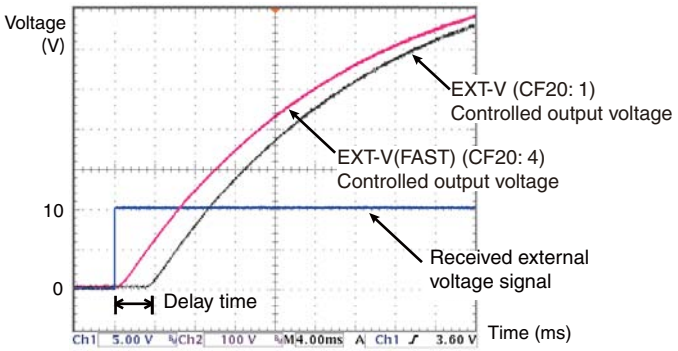


Fig.4-7 Voltage change example with CV control (external voltage signal: 0 V to 10 V)

- EXT-V CV CONT (CF20: 1)

  The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

  $$Eo = Ertg \times Vext / 10 \ [V] \qquad Vext = 10 \times Eo / Ertg \ [V]$$

  Because the PAT processes the signal internally, there is a delay between when the input signal is received and when the output voltage starts changing.

- EXT-V (FAST) CV CONT (CF20: 4)

  The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

  $$Eo = Ertg \times Vext / 10 \ [V] \qquad Vext = 10 \times Eo / Ertg \ [V]$$

The output voltage starts changing at almost the same time that the input signal is received. There is almost no delay.
In this mode, you cannot perform calibration of the output voltage control using external voltage. You can approach the desired output by making subtle adjustments to the input signal.

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- Make sure the polarity of Vext is correct. If the polarity is reversed, the PAT may break.
- Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins. Doing so may break the PAT.

External voltage (Vext) connection

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PAT and appears at the output. Thus, the output ripple noise may not meet the PAT's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext side, See "When using the external voltage (Vext)" on page 4-8.

Pins 21 and 22 of the J1 connector are used.

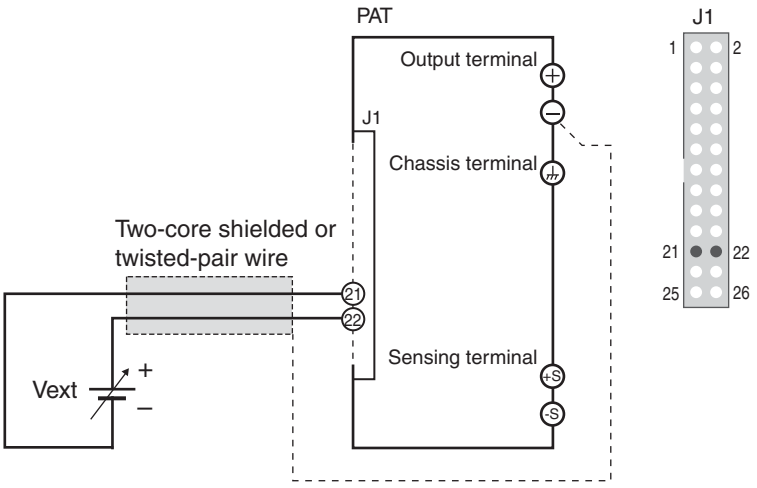


Fig.4-8 Connection of the output voltage control using external voltage

4.4.2 External resistance (Rext) control

See p. 3-17

To control the output voltage using Rext, select the CV control source in the CONFIG settings from the following two modes.

- EXT-R CV CONT 10 kΩ → MAX OUT (CF20: 2)

  The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  $Eo = Ertg \times Rext / 10$ [V] $Rext = 10 \times Eo / Ertg$ [V]

- EXT-R (FAIL SAFE) CV CONT 10 kΩ → 0 OUT (CF20: 3)

  The output voltage (Eo) varies in the range of the rated output voltage (Ertg) to 0 by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  $Eo = Ertg \times (10\text{-}Rext) / 10$ [V] $Rext = 10 \times (Ertg\text{-}Eo) / Ertg$ [V]

NOTE

- If Rext comes loose when using the 10 kΩ → MAX OUT CV mode, excessive voltage may be applied to the load. For safety reasons, it is recommended that fail-safe 10 kΩ → 0 OUT CV mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

Pins 21 and 22 of the J1 connector are used.

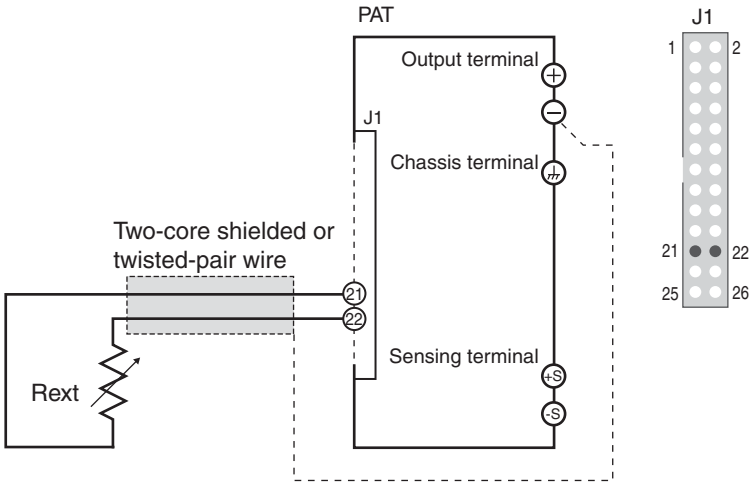


Fig.4-9 Connection of the output voltage control using Rext

4.5 Controlling the Output Current

This section explains the method used to control the output current using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ.

⚠WARNING **Possible electric shock.**

- **The insulation of the Vext or Rext and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

4.5.1 External Voltage (Vext) Control

See p. 3-17, p. 4-9

To control the output voltage using Vext, set the CV control source in the CONFIG settings to one of the following two modes.

- EXT-V CC CONT (CF21: 1)

  The output current (Io) varies in the range of 0 to the rated output current (Irtg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

  $$Io = Irtg \times Vext / 10 \text{ [A]} \qquad Vext = 10 \times Io / Irtg \text{ [A]}$$

  Because the PAT processes the signal internally, there is a delay between when the input signal is received and when the output current starts changing.

- EXT-V (FAST) CC CONT (CF21: 4)

  The output current (Io) varies in the range of 0 to the rated output current (Irtg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

  $$Io = Irtg \times Vext / 10 \text{ [A]} \qquad Vext = 10 \times Io / Irtg \text{ [A]}$$

  The output current starts changing at almost the same time that the input signal is received. There is almost no delay.
  In this mode, you cannot perform calibration of the output current control using external voltage. You can approach the desired output by making subtle adjustments to the input signal.

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- Make sure the polarity of Vext is correct. If the polarity is reversed, the PAT may break.
- Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins. Doing so may break the PAT.

External voltage (Vext) connection

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PAT and appears at the PAT output. Thus, the output ripple noise may not meet the PAT's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext side, See "When using the external voltage (Vext)" on page 4-8.

Pins 19 and 20 of the J1 connector are used.

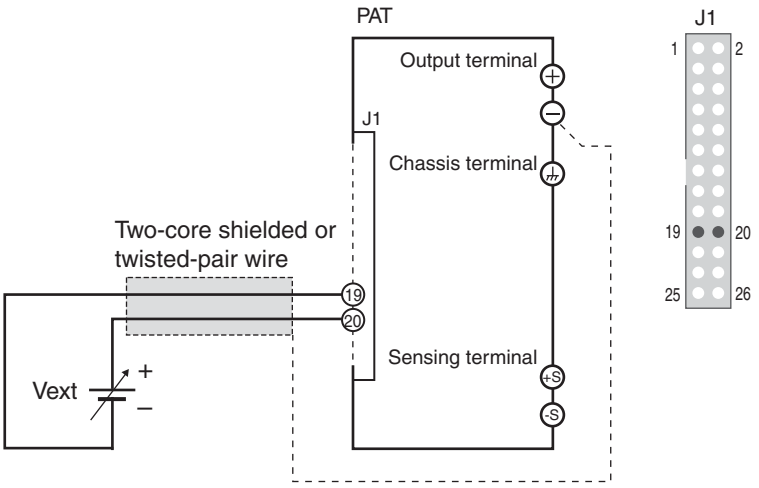


Fig.4-10 Connection of the output current control using Vext

4.5.2 External Resistance (Rext) Control

See p. 3-17

To control the output current using Rext, select the CC control source in the CONFIG settings from the following two modes.

- EXT-R CC CONT 10 kΩ → MAX OUT (CF21: 2)

  The output current (Io) varies in the range of 0 to the rated output current (Irtg) by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  $Io = Irtg \times Rext / 10$ [A] $Rext = 10 \times Io / Irtg$ [A]

- EXT-R (FAIL SAFE) CC CONT 10 kΩ → 0 OUT (CF21: 3)

  The output current (Io) varies in the range of the rated output current (Irtg) to 0 by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  $Io = Irtg \times (10\text{-}Rext) / 10$ [A] $Rext = 10 \times (Irtg\text{-}Io) / Irtg$ [A]

NOTE

- If Rext comes loose when using the 10 kΩ → MAX OUT CC mode, excessive current may flow through the load. For your safety, it is recommended that fail-safe 10 kΩ → 0 OUT CC mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

Pins 19 and 20 of the J1 connector are used.

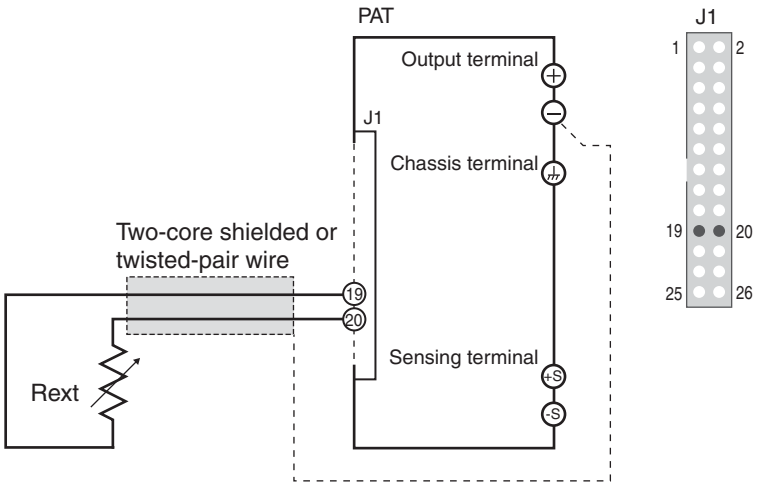


Fig.4-11 Connection of the output current control using Rext

4.6 Controlling the Output On/Off

This section explains the method used to control the on/off of the output by connecting an external contact.

⚠WARNING Possible electric shock.

- **The insulation of the external contact (S) and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

See p. 3-18

To control the output on/off using external contact, select the external control logic setting of output on/off in the CONFIG settings from the following two modes.

- Turn the output on with a high signal (default) (CF22: H)

  The output turns on when pin 14 of the J1 connector is set high (TTL level) or opened.

- Turn the output on with a low signal (CF22: L)

  The output turns on when pin 14 of the J1 connector is set low (TTL level).

If the output is set to off using an external contact, the OUTPUT switch on the front panel is invalid. If you are not controlling the output using an external contact, turn the output on by setting the external control logic setting of output on/off in the CONFIG settings to high (CF22: H).

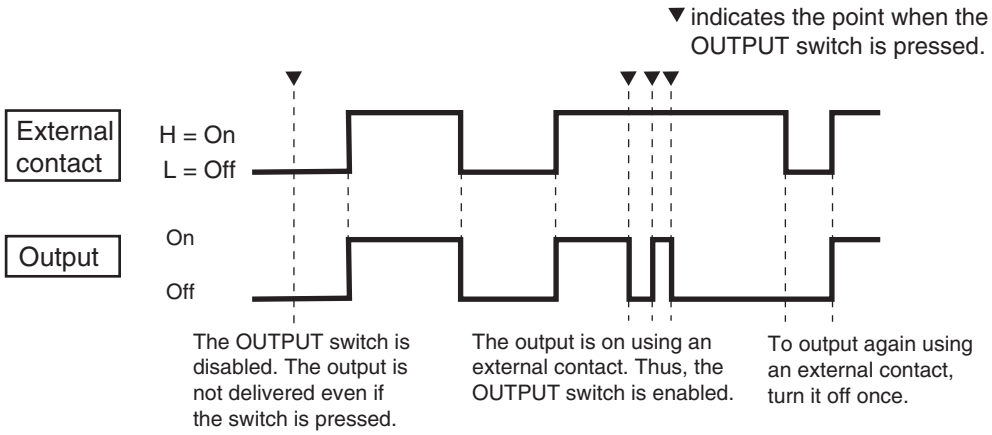

▼indicates the point when the OUTPUT switch is pressed.
External contact
H = On
L = Off
Output
On
Off
The OUTPUT switch is disabled. The output is not delivered even if the switch is pressed.
The output is on using an external contact. Thus, the OUTPUT switch is enabled.
To output again using an external contact, turn it off once.

Table 4-3 Output on/off control (example in which the output is on at high)

External contact connection.

Pins 13 and 14 of the J1 connector are used.

The release voltage across pins 13 and 14 is approx. 5 V maximum, and the short circuit current is approx. 500 µA maximum. (The internal circuit is pulled up to 5 V through 10 kΩ.)

Use parts with a contact rating of 5 Vdc and 0.5 mA for the external contact.

If multiple units are used under floating conditions and a single external contact is used to turn on/off the output, isolate the signal to each unit such as by using a relay on the external contact signal.

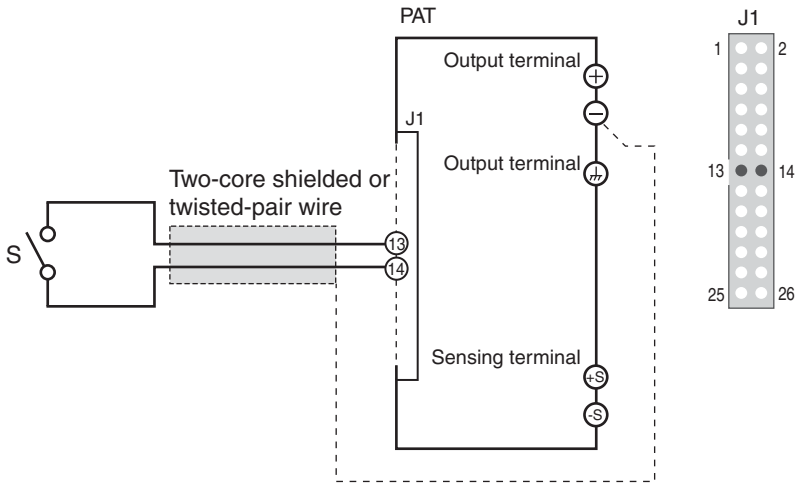


Fig.4-12 On/Off control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil side of the relay.

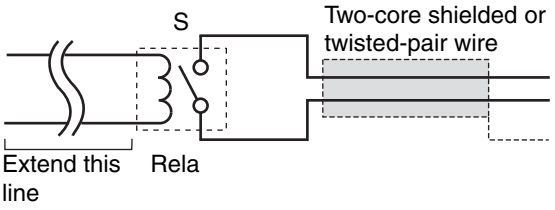


Fig.4-13 On/Off control using an external contact (for long-distance wiring)

4.7 Shutdown Control Using External Contact

This section explains the method used to trip the breaker (turn the POWER switch off) or turn the output off using external contact.

⚠WARNING **Possible electric shock.**

- **The insulation of the external contact (S) and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 8, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

See p. 3-19

To control the shutdown using an external contact, select the breaker trip setting when the shutdown signal is applied in the CONFIG settings from the following two modes.

- Not trip (default) (CF27: OFF)

  The output turns off when pin 12 of the J1 connector is set low (TTL level). The breaker is not tripped.

  To recover, set pin 12 high (TTL) or open the pin and turn the POWER switch off and then back on.

- Trip (CF27: ON)

  The breaker trips when pin 12 of the J1 connector is set low (TTL level). To recover, set pin 12 high (TTL) or open the pin and turn on the POWER switch.

Shutdown control connection

Pins 11 and 12 of the J1 connector are used.

The release voltage across pins 11 and 12 is approx. 5 V maximum, and the short circuit current is approx. 500 µA maximum. (The internal circuit is pulled up to 5 V through 10 kΩ.)

Use parts with a contact rating of 5 Vdc and 0.5 mA for the external contact.

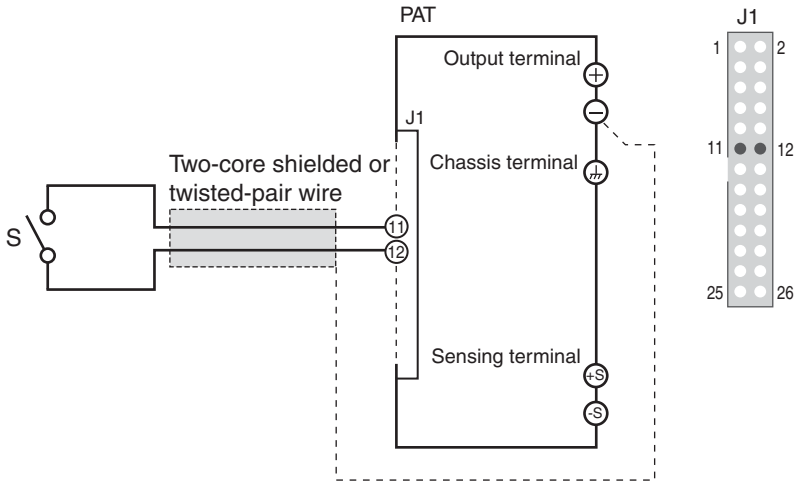


Fig.4-14 Shutdown control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil side of the relay.

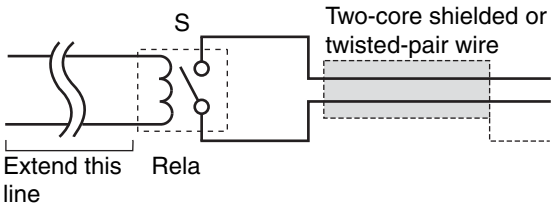


Fig.4-15 Shutdown control connection using an external contact (for long-distance wiring)

4.8 External Monitoring

External monitoring of the output voltage and output current

The J1 connector consists of monitor outputs for output voltage and output current.

Table 4-4 Monitor output of output voltage and output current

Pin No.	Signal name	Description
15 and 17	A COM	Common for remote control input Common terminal of the output monitor
18	V MON	Monitor output of output voltage 0 V to approx. 10 V for 0 to the rated output voltage
16	I MON	Monitor output of output current 0 V to approx. 10 V for 0 to the rated output current

⚠CAUTION • Shorting V MON and I MON to A COM can cause damage to the PAT.

- Monitor output rating

  Output impedance: 1 kΩ or less
  Maximum output current: Approx. 10 mA

The monitor outputs are used to monitor the DC voltage (mean value).

They cannot be used to accurately monitor the AC components (ripple, transient response, etc.) of the actual output voltage or current.

External monitoring of the operation mode

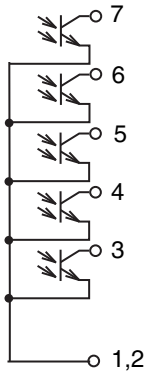
The J1 connector consists of status outputs that can be used to externally monitor the operating condition of the PAT. The status outputs consist of the following five items.

The outputs are open collector outputs of photocouplers; they are insulated from the internal circuits of the PAT.

The maximum rating of each signal terminal is as follows:

- Maximum voltage: 30 V
- Maximum current (Sink): 8 mA

Table 4-5 Status output

Pin No.	Signal name	Description	Circuit
7	CV STATUS	Set to low level when in constant voltage mode. Photocoupler collector output	
6	CC STATUS	Set to low level when in constant current mode. Photocoupler collector output	
5	ALM STATUS	Set to low level when a protection function is activated. Photocoupler collector output	
4	OUT ON STATUS	Set to low level when output is turned off. Photocoupler collector output	
3	PWR ON/OFF STATUS*1	Set to low level when the POWER switch is on (PWR ON STATUS) or when the POWER switch is turned off (POWER OFF STATUS: approx. 10 to 15 seconds). Photocoupler collector output	
1 and 2	STATUS COM	Common for status output Photocoupler emitter output	

See p. 3-18

*1 Status signal setting of the power on/off in the CONFIG settings is used to select whether to output a low level signal when the power is ON (CF23: 0) or when the power is off (CF23: 1).

5

Parallel/Series Operation

This chapter describes the functions of the master-slave series and parallel operations as well as the connection, setup, and operation procedures.

5.1 Master-Slave Parallel Operation

In master-slave parallel operation, PATs of the same model are connected to form a system, and one PAT is designated as the master, while the other PATs are designated as slaves. You can control the whole system by operating the master.

The output current can be expanded using master-slave parallel operation (maximum output current: the rated output current of a unit × number of units connected in parallel).

- Maximum number of units that can be connected is five including the master. (Two for the PAT850-9.4T.)

The difference in the output voltage and output current between the master unit and the slave unit is within approximately 5 % of the rating.

⚠CAUTION

- Only PATs of the same model can be connected in master-slave parallel operation.
- When using the PAT by itself, disconnect the parallel operation connections. Otherwise, the PAT may not operate properly.

5.1.1 Functions during Master-Slave Parallel Operation

The functions of the PAT during master-slave parallel operation are as follows:

Voltage display and current display

The voltage is displayed only on the master unit. It is not appeared on the display of the slave unit.

The total value of current in which the number of unit connected in the parallel operation is displayed in the current display part of the master unit. As for the voltage display part, the voltage value which was set at as the last setting on the master unit will be displayed. When the maximum output current value exceeds 999.9, the maximum current displays 9999.

See p. 3-18

If the actual number of connected units in Master-Slave Parallel Operation was different from the setting condition which were set by CONFIG setting in the “setting the number of units in Master-Slave Parallel Operation” (CF24), the current value on the display will not be shown properly.

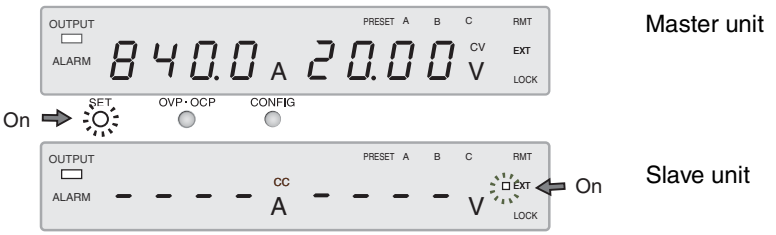


Fig.5-1 Panel display example during parallel operation (examples of output current 840 A)

You can only display the current on a slave unit. The current appears on the ammeter when the STORE switch is pressed.

When a device whose firmware version is earlier than 5.00 is being used as a slave unit, the currents of the slave units cannot be displayed.

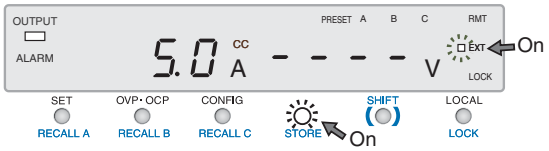


Fig.5-2 Slave unit display example during parallel operation (examples of output current is 5 A)

⚠CAUTION

- If the firmware version of the PAT40-200T is prior to 3.00, the total current is not displayed on the master unit when connected in the parallel operation. The current value is displayed on each unit. It is necessary to update the firmware version to 3.00 to display the total value on the master unit. When connecting the unit in the parallel operation, do not combine the unit with the firmware version prior to 3.00 of the PAT40-200T, it may causes the mis-operation.
  Contact your Kikusui distributor/agent when the firmware version prior to 3.00 of the PAT40-200T is combined in the system of master slave parallel operation. Refer to the page 1-6 , “1.4 Turning On" for confirmation of the firmware version.

See p. 3-25

Remote sensing

Available only on the master unit.

See Chapter 4

External control

Available only on the master unit.

See p. 4-21

External monitoring

- External monitoring of output voltage (V MON)
  Can be monitored on the master unit.
- External monitoring of output current (I MON)
  Can be monitored on the master unit.
- Status monitors
  The status of the constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on, and POWER switch on can be monitored on each master and slave unit. However, slave units always output the status of the constant current operation.
  For details on ALM STATUS, see the “Alarms” below.

⚠CAUTION

- Do not connect the common wires of the master and slave monitors outside the PAT. If the wire connecting the load comes loose, the common wire will break.

Alarm

If an alarm is detected, the units behave as follows:

- Master unit

  If an alarm is detected on the master unit, alarms on the slave units are also activated, and the output of the entire system is turned off or the breaker trips.

- Slave unit

  If an alarm signal is applied from the master unit, the output is turned off or the breaker trips on the slave unit independently.

See p. 3-19

In determining whether to function the breaker trip when the alarm is detected, it can be set by the config setting (CF27). To do the breaker trip as to when the OVP/OCP trips, it is set by the config setting (CF28) on the master unit and (CF27) on the slave unit.

See p. 3-9, p. 5-8

■ Releasing the alarm

If the breaker trips, turn the power switch on after eliminating the cause of the alarm. If the output is turned off, turn the power switch off from the slave unit and the master unit in this order, after eliminating the cause of the alarm, turn the power switch on from the slave unit and the master unit in this order.

5.1.2 Connection (Parallel Operation)

Up to five units including the master unit (Two for the PAT850-9.4T) can be connected.

Connecting the signal wires (parallel operation)

Fig.5-5 and Fig.5-6 shows an example when connecting two slave units.

If you are using the optional parallel operation power cable (PC01-PAT), you can use it immediately as it is already assembled.

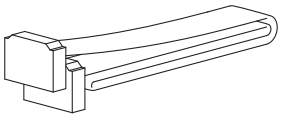
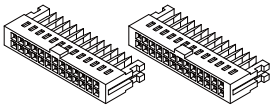


Fig.5-3 Optional parallel operation power cable (PC01-PAT)

See p. 4-3

If you are using the J1/J2 connector kit that comes with the package, refer to Fig.5-5 to make the connection. For tools needed for the connection, see Table 4-1.

At the factory shipment, the protection socket is attached to the J1/J2 connector. Keep this protection socket and be sure to attach when the J1/J2 connector is not used. If the protection socket is damaged or lost, contact Kikusui distributor/agent.



[84-49-0110]

Fig.5-4Protection socket

⚠WARNING **Possible electric shock.**

- **The J1/J2 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1/J2 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

⚠CAUTION

- To prevent errors, if the firmware versions of the devices are different when you perform master-slave parallel operation, use a device whose firmware version is 5.0X or later as the master unit.

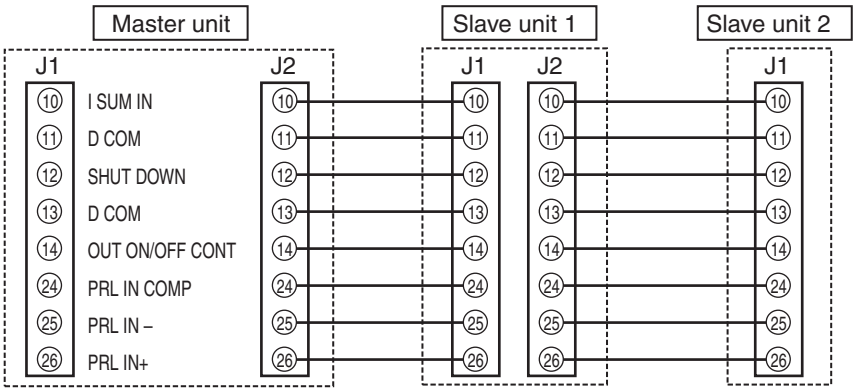


Fig.5-5 Connection for parallel operation (two slave units)

1. Choose the power supply that is to be the master unit.
2. Connect the J2 connector on the rear panel of the master unit to the J1 connector on the rear panel of slave unit 1 using the parallel operation power cable (PC01-PAT).
   If you are not using the PC01-PAT, connect pins 10 to 14 and 24 to 26.
3. Connect the J2 connector on the rear panel of slave unit 1 to the J1 connector on the rear panel of slave unit 2 using the parallel operation power cable (PC01-PAT).
   If you are not using the PC01-PAT, connect pins 10 to 14 and 24 to 26.

If slave units 3 and 4 are available, connect them in a similar manner.

Connecting the load (parallel operation)

⚠WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

⚠CAUTION

- When connecting the output terminal to the chassis terminal, be sure that the output terminal of the same polarity (positive or negative) for both the master and slave units is connected to the chassis terminal. If you connect the output terminal of different polarities for the master and slave units, the output is short-circuited through the GND cable of the power cable. This not only impedes the retrieval of correct voltage but also may burn out the chassis terminal cable.

- If necessary, connect the electrolytic capacitor with the range in value from several hundreds to several ten thousands of µF to the end of load terminal. The inductance of wiring and the phase transition by capacity cannot be disregarded, and the oscillation might be occurred. The electrolytic capacitor prevents the oscillation. The withstanding voltage of the electrolytic capacitor must be used for the range of 120 % or more of the ratings output voltage.
- Twist the positive and negative wires together and make the connection to the load using the shortest wire length possible. Oscillation may occur as a result of wiring inductance.

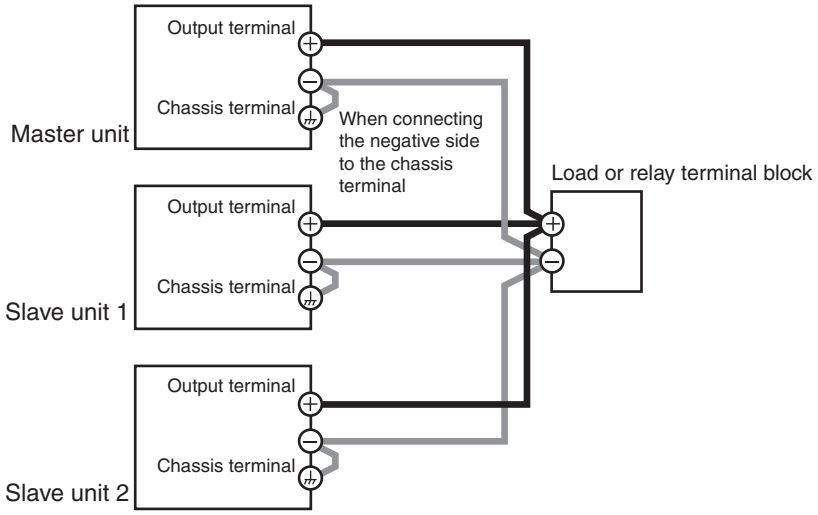


Fig.5-6 Load connection for parallel operation (two slave units)

1 Turn off the POWER switches on all power supply units to be connected in parallel.

See p. 2-6

2 Remove the OUTPUT terminal cover.

See p. 2-4

3 Connect the load wires to the output terminals of the master and slave units.

4 As shown in Fig.5-6, connect the load wires of the master and slave units to the load. If you use a relay terminal block, make sure that the wires used to connect the master and slave units are as short as possible.

Use load cables with sufficient current capacity. In addition, use the shortest load cables of the same length and cross-sectional area from each power supply to the load.

Wire the signal cable of the J1 and J2 connectors and load cables as far apart as possible.

5 Connect the output terminals (+ or) of the master and slave units to the chassis terminal.

Use the same polarities for the output terminals of the master and slave units.

If you are using the master and slave units under floating conditions, do not connect the output terminals to the chassis terminal.

6 Attach the OUTPUT terminal cover.

If slave units 3 and 4 are available, connect them in a similar manner.

5.1.3 Master-Slave Parallel Operation Setup

Designating the master and slave units

⚠CAUTION

- If the firmware versions of the devices are different when you perform master-slave parallel operation, use a device whose firmware version is 5.0X or later as the master unit.

See p. 3-18

Turn the output off and designate the master and slave units of the master-slave parallel operation. Set CF26 to 0 for the master unit and 1 for the slave units.

The settings take effect when you exit from the CONFIG settings.

Setting the number of units in Master-Slave Parallel Operation (Including the Master unit)

See p. 3-18

Turn the output off and set the number of units (CF24) in Master-Slave Parallel Operation.

The setting conditions become effective when you exit from CONFIG settings.

Setting the voltage and current

See p. 5-2

The voltage and current are set on the master unit. The total value of the master and slave units are delivered for the current.

When the setting number of units is set by the config setting (CF24) under the master-slave parallel operation, the maximum output current value (105 % of the rated output current of the product times number of units connected in parallel operation) is set, and it's value will be displayed when it is set to the setting value display (lights up the SET switch). The voltage value is set with the last setting of the master unit. When the OUTPUT switch is pressed with keeping this condition, its setting value will be output. Set the value as desired.

Setting the overvoltage protection (OVP) and overcurrent protection (OCP) of the master unit

See p. 3-9

Use the master-slave parallel operation, set the overvoltage protection (OVP) and overcurrent protection (OCP) of the master unit.

When the setting number of units is set by the config setting (CF24) under the master-slave parallel operation, the maximum over current protection value (111.5 % of the rated output current of the product times number of units connected in parallel operation) is set, and it's value will be displayed when it is set to the OVP/OCP setting value display (lights up the OVP/OCP switch). The value of over voltage protection is set with the last setting of the master unit.

CONFIG parameters that can be set on the slave unit

See p. 3-14

- CF13 Error message display setting
- CF23 Status signal setting of the power on/off
- CF26 Master-slave parallel setting

- CF27 Breaker trip setting when the shutdown signal is applied
- CF28 Breaker trip setting when the OVP or OCP is activated
- CF40 to CF43 RS232C settings
- CF51 GPIB address setting
- CF54 Remote interface setting

NOTE

- Make sure to match the number of units in Master-Slave Parallel Operation for the setting number (CF24) and the actual number of connected units. If the setting number of units are different from the actual number of units, it is unable to set properly for such a current value setting (including EXT CC CONT), overcurrent protection (OCP) setting, and also the measured current value will not be appeared properly on the display.

5.1.4 Starting the Master-Slave Parallel Operation

Turning the power on

1. Turn on the POWER switch of the slave units.
2. Turn on the POWER switch of the master unit.

Turning the power off

1. Turn off the POWER switch of the slave units.
2. Turn off the POWER switch of the master unit.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds (40 seconds for 400 V input model) after the fan stops. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

Turning the output on/off

Turn the output on/off using the OUTPUT switch on the master unit.

5.2 Series Operation

⚠WARNING

- **Models with output voltages of 250 V or more cannot be connected in series. Connecting the models in series would be dangerous because the output voltage would exceed the isolation voltage of the PAT.**

See p. 4-5

Two of any one of the following models can be connected in series: PAT20-400T, PAT30-266T, PAT40-200T, PAT60-133T, PAT80-100T, and PAT160-50T. Master-slave operation is not possible. The total of the output voltages of the two units is supplied to the load. The voltage setting accuracy is the same as that of each unit.

5.2.1 Functions during series operation

The functions of the PAT during series operation are as follows:

Voltage display and current display

Add the voltages of unit 1 and unit 2 to obtain the total output voltage.

Fig.5-7 Panel display example during series operation

See Chapter 4

External control

Can be used.

See p. 4-21

External monitoring

⚠WARNING

- **When monitoring the output voltage or current during series operation, the common electric potential of the monitor signal of unit 1 and unit 2 is different.**

- External monitoring of output voltage (V MON)

  The output voltage of each unit can be monitored.

- External monitoring of output current (I MON)

  The output current of each unit can be monitored.

- Status monitors

  Constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on status, POWER switch on status, and so on can be monitored on each unit.

Remote sensing

See p.3-25

When you perform remote sensing, connect the PATs in series, and then connect the sensing line to them as shown in Fig.5-8.

⚠CAUTION

- If the sensing wires are not connected properly, the load may be exposed to excessive voltage and the PATs may be damaged.
- Connect an electrolytic capacitor (C) with a capacitance of a few hundreds of μF to a few tens of thousands of μF to the load terminals as necessary. The wiring inductance and capacitance can cause phase shifting at a level that must be dealt with and can also cause oscillation. Connecting an electrolytic capacitor will prevent such oscillation.
  Use an electrolytic capacitor with a withstand voltage that is 120% or more of the total of the rated output voltages of the PATs that are connected in series.

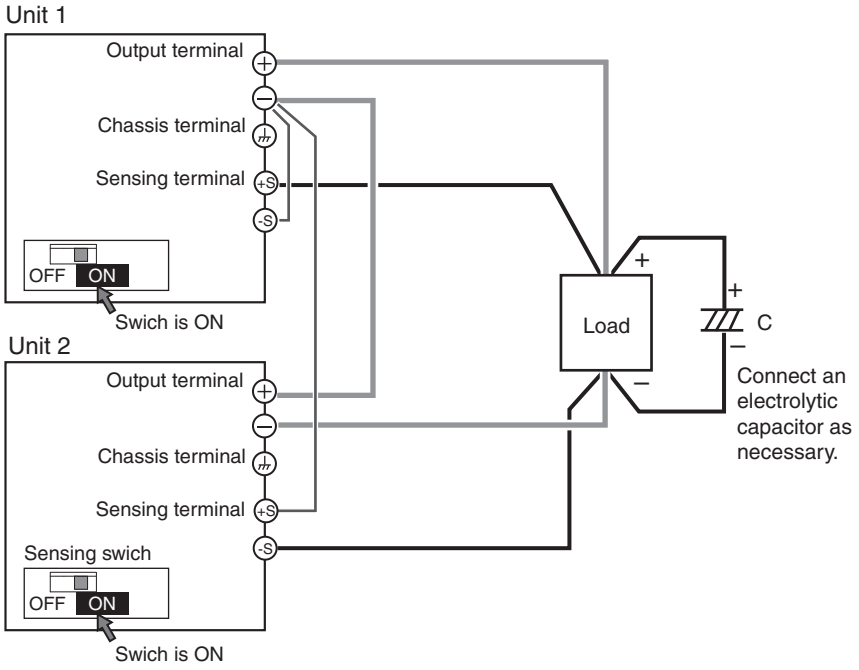


Fig.5-8 Connecting the sensing wires during series operation

Alarm

All of the alarms that are detected on a single unit are also detected during series operation.

See p. 3-9, p. 5-12

■ Releasing the alarm

If the breaker trips, turn the power switch on after eliminating the cause of the alarm. If the output is turned off, turn the power switch off of the unit 1 and the unit 2 in this order, after eliminating the cause of the alarm, turn the power switch on of the unit 1 and the unit 2 in this order.

5.2.2 Load Connection (Series Operation)

WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

CAUTION

- Connect an electrolytic capacitor (C) with a capacitance of a few hundreds of μF to a few tens of thousands of μF to the load terminals as necessary. The wiring inductance and capacitance can cause phase shifting at a level that must be dealt with and can also cause oscillation. Connecting an electrolytic capacitor will prevent such oscillation.
  Use an electrolytic capacitor with a withstand voltage that is 120% or more of the total of the rated output voltages of the PATs that are connected in series.

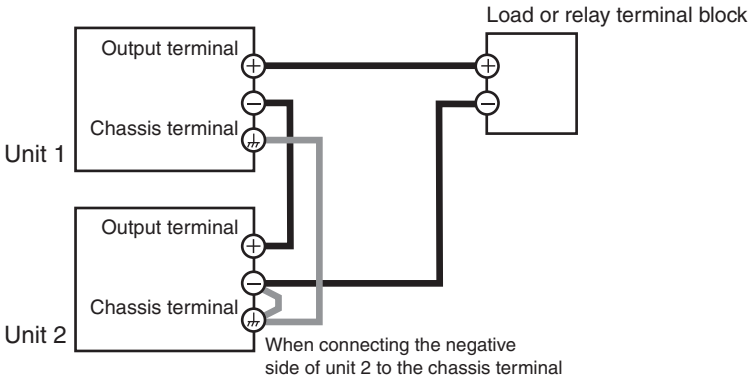


Fig.5-9 Load connection for series operation
(Example in which the negative terminal of unit 2 is connected to the chassis terminal)

1. Turn off the POWER switches on all power supply units to be connected in series.
2. Remove the OUTPUT terminal cover.
3. As shown in Fig.5-9, connect the load and the PAT using the load wires.

   Use load cables with sufficient current capacity. Connect the load wires at the shortest length possible. If the voltage drop in the output cable is large, the difference in the potential between power supply units and the load effect become large.
4. Connect the output terminals of unit 1 and unit 2.
5. Connect one of the negative terminal or the positive terminal of unit 1 or unit 2 to the chassis terminal.
6. Attach the OUTPUT terminal cover.

See p. 2-6
See p. 2-4

5.2.3 Series Operation Setup

Setting the voltage and current

See Fig.5-7

The voltage and current are set on each unit. The voltage that is delivered is the sum of the voltages of the two units. Set the same value for the current on each unit.

Setting the overvoltage protection (OVP) and overcurrent protection (OCP)

See p. 3-9

Overvoltage protection (OVP) and overcurrent protection (OCP) must be configured on each unit when carrying out series operation. Set the same values on each unit.

5.2.4 Starting the Series Operation

Turning the power on/off

Turn on/off the POWER switches on unit 1 and unit 2.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds (at least 40 seconds for 400 V input model) after the fan stops. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

Turning the output on/off

Turn on/off the OUTPUT switches on unit 1 and unit 2.

6

Remote Control

This chapter provides a general explanation of the remote control function. For details on commands, see the Communication Interface Manual on the accompanied CD-ROM.

6.1 Remote Control Overview

In addition to using the front panel, the PAT can be controlled remotely using the following interfaces.

- RS232C interface
- GPIB interface (factory option)
- USB interface (factory option)
- LAN interface (factory option)

The PAT is equipped with RS232C as standard.

If the factory option interface board is installed, you can use GPIB, USB or LAN. The GPIB, RS232C, USB and LAN interfaces cannot be used simultaneously.

The remote interface complies with IEEE Std 488.2-1992 and SCPI Specification 1999.0.

Use the SCPI commands only after you have understood the SCPI command syntax for the PAT.

When the PAT is operating under remote control, the RMT LED on the display on the front panel illuminates. To switch from the remote mode to the local mode (panel operation) from the panel, press the LOCAL switch.

Instrument Interface Standards

The PAT conforms to the following standards.

- IEEE Std 488.2-1992 IEEE Standard Codes, Formats, Protocols, and Common Commands For Use With IEEE Std 488.1-1987
- IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation
- Standard Commands for Programmable Instruments (SCPI) version 1999.0
- Universal Serial Bus Specification Rev 2.0
- Universal Serial Bus Test and Measurement Class Specification (USBTMC) Rev 1.0
- Universal Serial Bus Test and Measurement Class, Subclass USB488 Specification (USBTMC-USB488) Rev 1.0
- TCP/IP instrument Protocol Specification VXI-11 Rev 1.0

6.2 Interface Setup

6.2.1 RS232C Control (Standard Equipped)

When the PAT is shipped from the factory, the RS232C connector has a cover. Keep the cover so that you can attach it to the RS232C connector when the connector is not in use. For safety, always attach the cover to the RS232C connector when the connector is not being used. If the cover is damaged or lost, contact your Kikusui agent or distributor.

[P1-000-093]

Fig.6-1 RS232C connector cover

The RS232C port on the PAT is a standard D-sub 9-pin male connector.

Check that the POWER switches of the PAT and computer are off, and connect the PAT to the computer using a standard cross cable (null modem cable).

Use a D-sub 9-pin female-to-female AT type for the cross cable. Fig.6-2 shows the connector pin arrangement.

The PAT does not use hardware handshaking (as shown in the cross cable example 2).

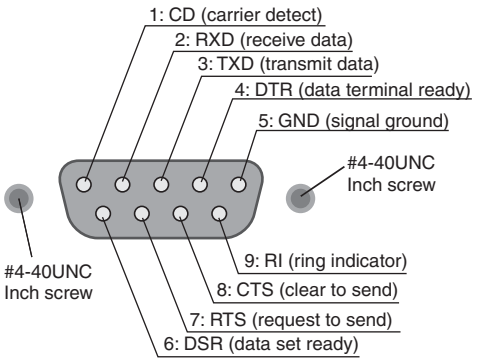

1: CD (carrier detect)
2: RXD (receive data)
3: TXD (transmit data)
4: DTR (data terminal ready)
5: GND (signal ground)
#4-40UNC
Inch screw
#4-40UNC
Inch screw
9: RI (ring indicator)
8: CTS (clear to send)
7: RTS (request to send)
6: DSR (data set ready)
Facing the PAT rear panel
1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9
D-sub 9-pin female
D-sub 9-pin female
Wiring configuration of the cross cable
* : Communication Iline used of this producct

Fig.6-2 9-pin AT type connector

RS232C configuration

See p. 3-15, p. 3-21

1 If an option board is installed, select RS232C in the CONFIG settings (CF54: 232C).

2 In the CONFIG settings, set the RS232C data rate (CF40), RS232C data length (CF41), RS232C stop bit (CF42), and RS232C flow control (CF43).

For the settings, see Table 6-1.

Protocol

Table 6-1 shows the RS232C protocol. Underline indicates factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 6-1 RS232C protocol

Item	Setting
Connector	9-pin D-sub terminal on the rear panel
Baudrate	1200 bps/ 2400 bps/ 4800 bps/ 9600 bps/ 19200 bps/ 38400 bps (1.2/2.4/4.8/9.6/19.2/38.4)
Data length	(8 bits or 7 bits)
Stop bit	(1 bit or 2 bits)
Parity	Fixed to none
Flow (X-flow control)	XFLOW / None (on/off)

Break signal

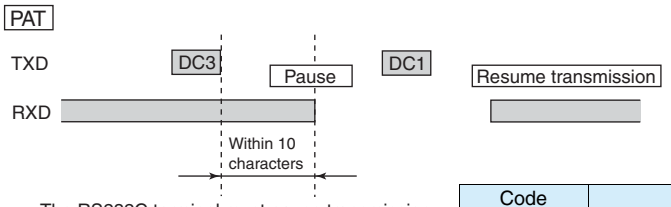
The break signal functions as a substitute for the IEEE488.1 dcl/sdc (Device Clear, Selected Device Clear) message.

RS232C communication

Use flow control for RS232C communication. DC (device control) codes are used as control codes.

Transmission/reception may not work correctly through unilateral transmission.

Table 6-2 DC codes



Code	Function	ASCII code
DC1 (Xon)	Request to send	11H
DC3 (Xoff)	Transmission stop request	13H

Fig.6-3 RS232C terminal and transmission control of the PAT

6.2.2 GPIB Interface (Option)

This interface valid only when the factory option GPIB interface board is installed.

GPIB connection

Use a standard IEEE488 cable to connect the PAT to the computer.

GPIB configuration

See p. 3-15, p. 3-21

1 Select GPIB (CF54: GPIb) in the CONFIG settings.

2 Set the address (CF51: 1 to 30) in the CONFIG settings.

The address is set to 1 as factory default setting.

GPIB function

Table 6-3 GPIB function

Function	Subset	Description
Source handshaking	SH1	Full capability
Acceptor handshaking	AH1	Full capability
Talker	T6	Function available
Listener	L4	Function available
Service request	SR1	Full capability
Remote local	RL1	Full capability
Parallel polling	PP0	No capability
Device clear	DC1	Full capability
Device trigger	DT1	Full capability
Controller	C0	No capability
Electrical interface	E1	Open collector driver

Service request

Service request and serial polling functions are implemented.

6.2.3 USB Interface (Option)

See p. 6-10

This interface valid only when the factory option USB interface board is installed.

A device driver supporting USB T&M Class (USBTMC) is required to control the PAT through the USB interface. The USBTMC driver is automatically installed by the VISA library.

USB configuration

See p. 3-15, p. 3-21

Select USB (CF54: uSb) in the CONFIG settings.

Service request

The PAT is equipped with service request and serial polling functions.

USB function

Complies with USB Specification 2.0.

Complies with USBTMC Specification 1.0 and USBTMC-USB488 Specification 1.0.

Data rate: 12 Mbps maximum (full speed)

VID (vendor ID): 0x0B3E

PID (product ID): 0x100E

You can check the VID (CF52) and PID (CF53) in the CONFIG settings.

6.2.4 LAN interface (Option)

This interface valid only when the factory option LAN interface board is installed.

See p. 6-10

To use the LAN interface to control the PAT, middleware that supports the VXI-11 protocol must be installed on the controller. The middleware is installed automatically by the VISA library.

There is a Web browser interface to the PAT embedded in the LAN interface board. You can configure the LAN interface settings from your PC's Web browser.

For information about be set in detail of the LAN interface, see the accompanying CD-ROM.

For information on topics such as connecting to your corporate LAN, your IP address, your host name, and security, contact your network administrator.

LAN connection

Use a standard LAN cable (category 5 and straight) to connect the PAT to a network hub or router. Use a crossover cable when making a direct connection.

LAN setting

See p. 3-22

Normally, you should use a DHCP server to set the IP address automatically.

1. Select LAN (CF54 : LAn) by the CONFIG setting.
2. Select DHCP (CF55 : On) by the CONFIG setting.
3. Select AUTO IP (CF56 : On) by the CONFIG setting.

If you are connecting the PAT and the PC directly, set DHCP (CF55) to OFF, and set AUTO IP (CF56) to ON to set the IP address automatically. You cannot set the IP address from the panel. To set a fixed IP address, first set the IP address automatically, and then set a fixed address by accessing the PAT through a Web browser.

See p. 3-22

You can use the CONFIG settings (CF57 to CF60) to check the IP address.

When you are going to use a fixed IP address over a long period of time or at intervals, we recommend that you specify a host name. To set a host name, access the PAT through a Web browser.

Service request

The PAT is equipped with service request and serial polling functions.

LAN function

Depending on the operation that you perform through your Web browser, the PAT may need to connect to the Internet.

Comply with LXI Class C, Specification 1.2

Comply with VXI-11 protocol

Communication speed: Maximum 100 Mbps (Auto negotiation)

DHCP client function

AUTO IP function

From your Web browser, you can (Internet Explorer version 7.0 or later; Mozilla Firefox version 3.0 or later; Opera version 9.0 or later or Safari version 3.0 or later):

- LAN setting, Security setting
- Use of temporary control application
- Firmware update

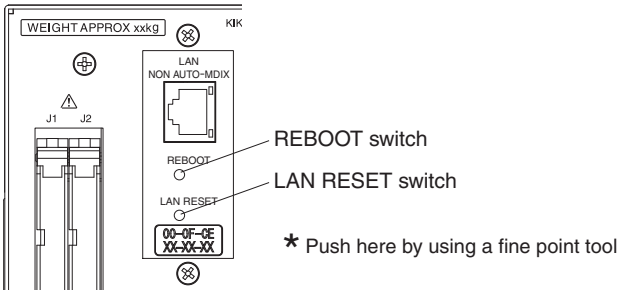


Fig.6-4 REBOOT switch and LAN RESET switch

■ REBOOT switch

When you keep pressing the "REBOOT" switch for more than 2 seconds, the LAN will reboot. However, the setting condition of LAN interface will not be changed.

■ LAN RESET switch

When you keep pressing the "LAN RESET" switch for more than 2 seconds, all of the setting of LAN interface returns to the factory default setting. It can be used when neither the security password nor IP address are forgotten.

Either switch doesn't reflect to the panel setting of the product. In case the product is in the state of remote mode, it can be switched (from the panel operation) to the local mode.

⚠WARNING

- **There are possible damage on the equipment or an electric shock. The LAN interface can be accessed from any place on the network. Set the security when it is necessary.**
  Security can be set by the password protection and the host limitation by IP address. Refer to the accompanying CD-ROM for setting procedure.

NOTE

- Do not touch neither REBOOT switch nor LAN RESET switch inadvertently while the automatic measurement system is in operation. It may cause to mis-operation.
- The LAN interface should be shifted remotely by the command unlike other interfaces. Set it by the SCPI command "SYSTem:REMote" to the remote state. When you do a remote programming, transmit this command to the front of the program.

6.3 Contents of the Included CD-ROM

Put the included CD-ROM into the CD-ROM drive. A start window will appear momentarily. If the start window does not appear, open the CD-ROM in Windows Explorer, and then double-click index.html to display the start window.

- Driver

  IVI-COM

  KI-VISA
- Operation manual

  User's Manual (PDF)

  Communication Interface Manual (HTML)

6.4 Installing the VISA library

VISA (Virtual Instrument Software Architecture) was developed by the VXIplug&play Systems Alliance. It is the standard specification for measurement instrument connection software.

You have to install one of the following VISA libraries (driver software that is implemented according to the VISA specifications).

Do not install multiple VISA libraries on the same PC. Doing so may cause errors.

VISA libraries that are older than the specified version do not support USB.

- NI-VISA by National Instruments (Ver. 3.0 or later, Ver. 3.2 or later for Windows 2000 and Windows XP)
- Agilent VISA by Agilent Technologies (Agilent IO Libraries M01.00 or later)
- KI-VISA Ver. 3.0.0 or later

Installing KI-VISA

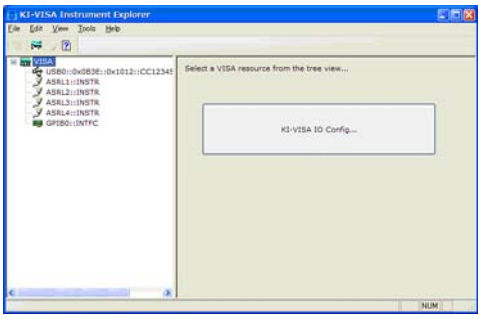
KI-VISA is Kikusui's original VISA library that supports VXIplug&play VISA Specifications. You can download the most recent version of this library from the Kikusui Electronics Corporation website (http://www.kikusui.co.jp/en/download/).

KI-VISA is not required if NI-VISA or Agilent VISA is already installed.

1. Load the accompanying CD-ROM into the CD-ROM drive.
2. Move to the VISA folder using the menu program of the CD-ROM or Explorer.
3. Double-click Kivisa_x_x_x.exe.

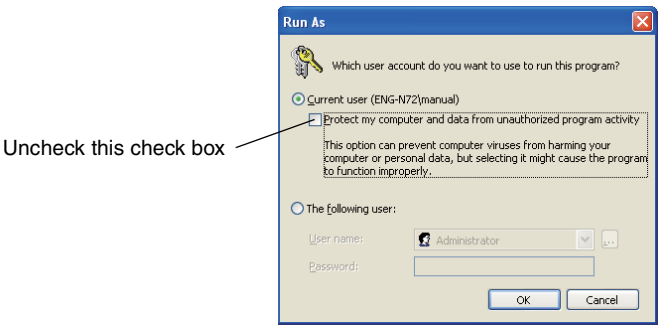
   The value for x varies depending on the revision of the VISA library stored on the CD-ROM.
4. Proceed with the installation according to the instructions on the screen.

   After you install KI-VISA, the KI-VISA Instrument Explorer opens.
5. Click KI-VISA Config.



6. Click the USB(USBTMC) tab and then Run Driver Wizard(WINUSB.SYS).

7 Uncheck the Protect my computer and data from unauthorized program activity check box, and then click OK.


Uncheck this check box
Run As
Which user account do you want to use to run this program?
Current user (ENG-N72\manual)
Protect my computer and data from unauthorized program activity
This option can prevent computer viruses from harming your computer or personal data, but selecting it might cause the program to function improperly.
The following user:
User name:
Administrator
Password:
OK
Cancel

8 Follow the displayed instructions to install the USBTMC driver.

6.5 Command Details

For details on commands, see the Communication Interface Manual on the accompanied CD-ROM.

The Communication Interface Manual is provided in HTML format. The HTML manual can be viewed using the following browsers.

Operating environment: Windows 98 or later

Browser: Microsoft Internet Explorer 5.5 or later

The list of messages in the Communication Interface Manual is provided in PDF format. You can view it using Adobe Reader 6.0 or later.

7

Maintenance

This chapter describes maintenance such as cleaning, inspecting, and calibrating.

7.1 Inspection

Periodic inspection is essential to maintain the initial performance of the PAT over an extended period.

Check for tears in the power cable insulation and breaks in the terminal block.

⚠WARNING

- **Tears in the insulation coating may cause electric shock or fire. If a tear is found, stop using it immediately.**

To purchase accessories or options, contact your Kikusui agent or distributor.

7.2 Cleaning

Cleaning the Dust Filter

Two dust filter sheets are installed on the inside of the louver on the front panel. Periodically clean the filter to prevent clogging.

⚠CAUTION

- Clogged filters hinder the cooling of the inside of the PAT and can cause a malfunction and shortening of the service life.
- When the PAT is in operation, air is sucked through the dust filter to cool the inside.
  If moisture is present in the dust filter, the temperature or humidity inside the PAT increases and may cause a malfunction.

Removing the dust filter

1 Remove the lower louver from the panel.

While lifting the bottom of the removal mark with your finger tips, slide the entire louver to the right. Then, pull it toward you.

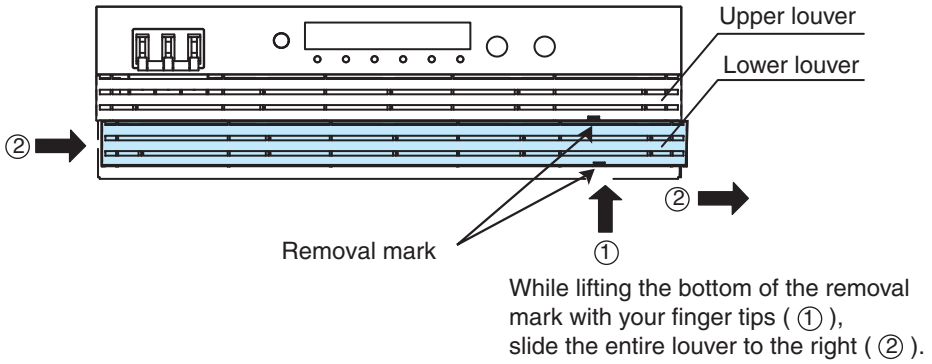

Upper louver
Lower louver
②
②
Removal mark
①
While lifting the bottom of the removal mark with your finger tips (①), slide the entire louver to the right (②).

Fig.7-1 Louver removal

2 Remove the upper louver in the same manner as step 1 .

3 Remove the dust filter from the inside of the louver and clean it.

There is a hook on the louver tab. Be sure not to get the dust filter caught in the hook when removing the dust filter from the louver.

Dispose of foreign particles and dust from the dust filter using a vacuum cleaner. If the filter is extremely dirty, clean it using a water-diluted neutral detergent and dry it completely.

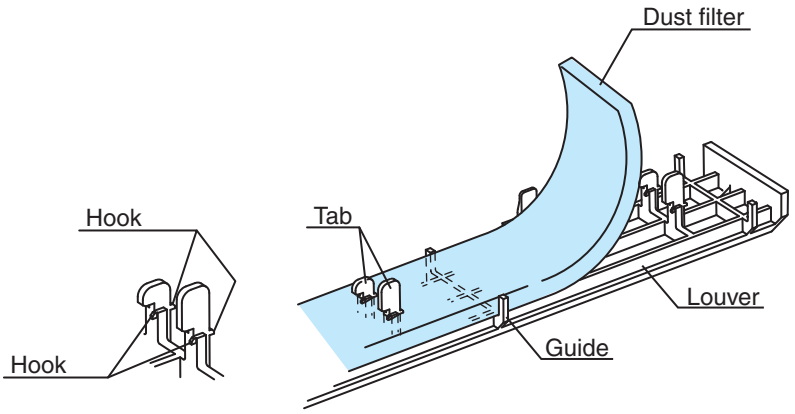


Fig.7-2 Dust filter removal

Attaching the dust filter

1 Align the dust filter along the guide and attach it to the louver.

Be sure to attach it firmly until the tab hooks of the louver completely passes through the dust filter.

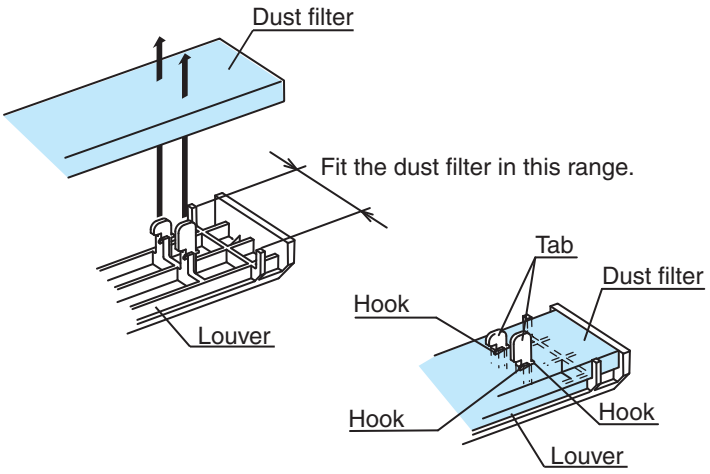


Fig.7-3 Dust filter attachment

2 Attach the upper louver first.

The shapes of the upper and lower dust filters are different. The upper dust filter has a cutout.

Align the tab on the inner side of the louver to the panel groove and slide the louver to the left to attach it.

You can easily attach the louver by aligning the long tabs (five locations) with the grooves.

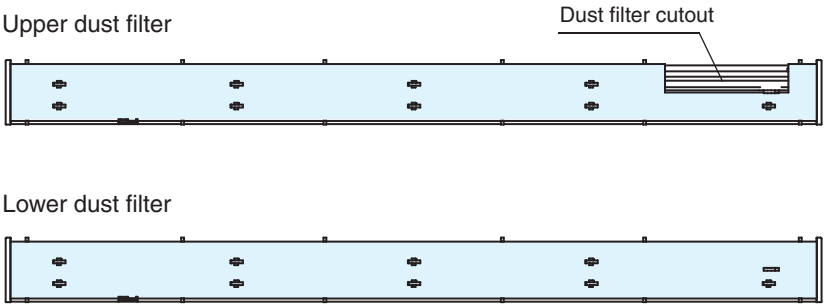


Fig.7-4 Dust filter as seen from the rear

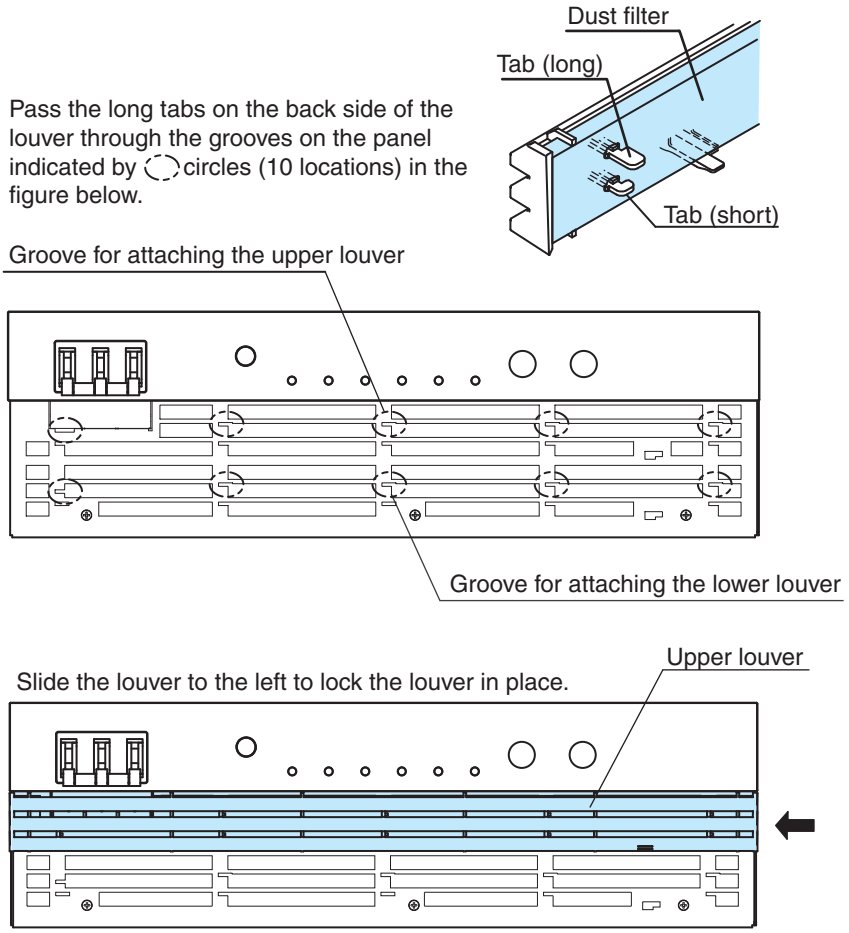

Dust filter
Tab (long)
Pass the long tabs on the back side of the louver through the grooves on the panel indicated by ◌ circles (10 locations) in the figure below.
Tab (short)
Groove for attaching the upper louver
Groove for attaching the lower louver
Upper louver
Slide the louver to the left to lock the louver in place.

Fig.7-5 Louver attachment

3 Attach the lower louver in the same manner as step 2 .

⚠CAUTION

- Pay attention to the shape of the dust filter when attaching the louver to the panel. If you attempt to attach the wrong louver by force, the louver may break.

7.3 Calibration

The PAT is shipped after carrying out appropriate calibrations. We recommend periodic calibration to maintain the performance over an extended period.

For calibration, contact your Kikusui agent or distributor.

If you are going to calibrate the PAT yourself, follow the procedures below.

The calibration procedures given in this section includes all calibration items of the PAT.

7.3.1 Calibration Overview

The following six calibration items are available.

- Output voltage and voltmeter
- Output current and ammeter
- Overvoltage protection
- Overcurrent protection
- Output voltage control
- Output current control

Test Equipment Required

For calibration, the following equipment is necessary.

- DC voltmeter (DVM) with measuring accuracy of 0.02 % or better.
- Shunt (See Table 7-1)

Table 7-1 Recommended shunt resistors

Model	Shunt resistors	
	Rating	Tolerance
PAT20-400T	500 A/50 mV (0.1 mΩ)	< ± 0.1 %
PAT30-266T	300 A/50 mV (0.17 mΩ)	
PAT40-200T	200 A/50 mV (0.25 mΩ)	
PAT60-133T	150 A/50 mV (0.3 mΩ)	
PAT80-100T	100 A/50 mV (0.5 mΩ)	
PAT160-50T	50 A/50 mV (1 mΩ)	
PAT250-32T	50 A/50 mV (1 mΩ)	
PAT350-22.8T	30 A/50 mV (1.67 mΩ)	
PAT500-16T	20 A/50 mV (2.5 mΩ)	
PAT650-12.3T	15 A/50 mV (3.34 mΩ)	
PAT850-9.4T	10 A/50 mV (5 mΩ)	

- 10 kΩ resistor with accuracy of 1 % or better
- DC power supply (variable power supply that can output +10 V, used as a voltage source)

Environment

Perform calibration under the following environment.

- Temperature: 23 °C ± 5 °C
- Relative humidity: 80 % or less

To minimize the calibration error due to initial drift, warm up the PAT for at least 30 minutes before calibration. In addition, warm up the DVM and shunt resistor adequately.

7.3.2 Calibration Procedure

Be sure to carry out the calibration items to the last step. If you move to a different type of calibration in the middle of another calibration or if you turn the POWER switch off, the calibration is invalid.

⚠WARNING Possible electric shock.

- **Be sure to turn the POWER switch off before touching the output terminal.**
- **Be sure to connect the output terminal and the chassis terminal.**

Calibration mode indication

The ammeter display switches between CAL. 1 to CAL. 8 depending on the calibration mode type. CAL. 1 and CAL. 2 as well as CAL. 3 and CAL. 4 are calibrated subsequently.

In the CAL. 5 and CAL. 7 calibration modes, you cannot calibrate EXT-V (FAST) CV CONT or EXT-V (FAST) CC CONT.

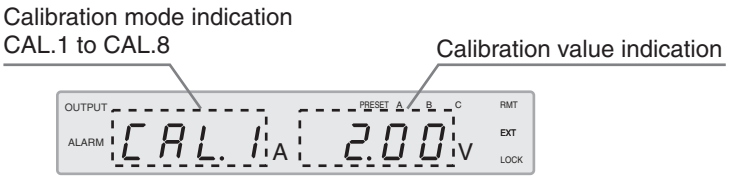


Fig.7-6 Panel display example of calibration mode

CAL.1: Calibration of the output voltage and voltmeter

CAL.2: Calibration of the overvoltage protection (OVP)

CAL.3: Calibration of the output current and ammeter

CAL.4: Calibration of the overcurrent protection setting (OCP)

CAL.5: Calibration of the output voltage control using external voltage (EXT-V CV CONT)

CAL.6: Calibration of the output voltage control using external resistance (EXT-R CV CONT)

CAL.7: Calibration of the output current control using external voltage (EXT-V CC CONT)

CAL.8: Calibration of the output current control using external resistance (EXT-R CC CONT)

Calibration procedure of the output voltage, voltmeter, and the overvoltage protection setting (CAL.1 and CAL.2)

Calibrate CAL.1 and CAL.2 consecutively.

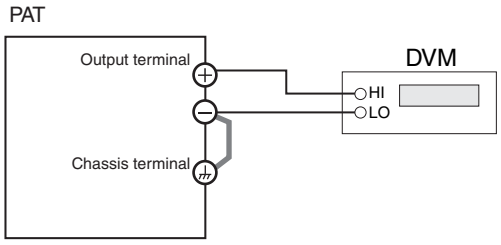


Fig.7-7 Connection for CAL.1 and CAL.2

1. Turn the POWER switch off.
2. Connect a DVM to the output terminal.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the OUTPUT switch to turn the output on.

   The OUTPUT LED illuminates.
5. Turn the VOLTAGE knob to set the DVM reading to 5 % of the rated voltage.
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the LOCK LED illuminates.
7. Press the SET switch.

   The voltmeter shows the rated voltage value.
8. Turn the VOLTAGE knob to set the DVM reading of the rated voltage.
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Press the LOCK (SHIFT+LOCAL) switch to execute the calibration of the overvoltage protection (OVP).

    The ammeter displays “CAL.2,” and the voltmeter displays 5 % of the rated voltage value. The calibration is automatically executed. In the middle of the calibration, the voltmeter display changes to the rated voltage value.

    When the calibration completes, the PRESET B LED illuminates.
11. Turn the POWER switch off to finish the calibration of the output voltage, voltmeter, and the overvoltage protection.

Calibration procedure of the output current, ammeter, and the overcurrent protection setting (CAL.3 and CAL.4)

Calibrate CAL.3 and CAL.4 consecutively.

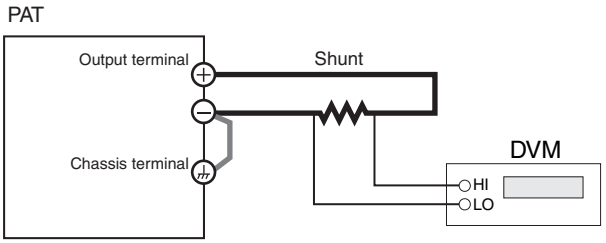


Fig.7-8 Connection for CAL.3 and CAL.4

1. Turn the POWER switch off.
2. Connect a shunt resistor to the output terminal, and connect the DVM to across the shunt resistor.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the OVP•OCP switch.

   The voltmeter shows “CAL.3,” and the ammeter shows 5 % of the rated current value.
5. Press the OUTPUT switch to turn it on.

   The OUTPUT LED illuminates.
6. Turn the CURRENT knob to set the DVM reading to 5 % of the rated current.
7. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the LOCK LED illuminates.
8. Press the OVP•OCP switch.

   The ammeter shows the rated current value.
9. Turn the CURRENT knob to set the DVM reading to the rated current.
10. Press the RECALL A (SHIFT+SET) switch.

    The calibration of this item is set, and the EXT LED illuminates.
    Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
11. Press the LOCK (SHIFT+LOCAL) switch to execute the calibration of the overcurrent protection (OCP).

    The voltmeter displays “CAL.4,” and the ammeter displays 5 % of the rated current value. The calibration is automatically executed. In the middle of the calibration, the ammeter display changes to the rated current value.
    When the calibration completes, the PRESET B LED illuminates.
12. Turn the POWER switch off to finish the calibration of the output current, ammeter, and the overcurrent protection.

Calibration procedure of the output voltage control using external voltage (CAL.5)

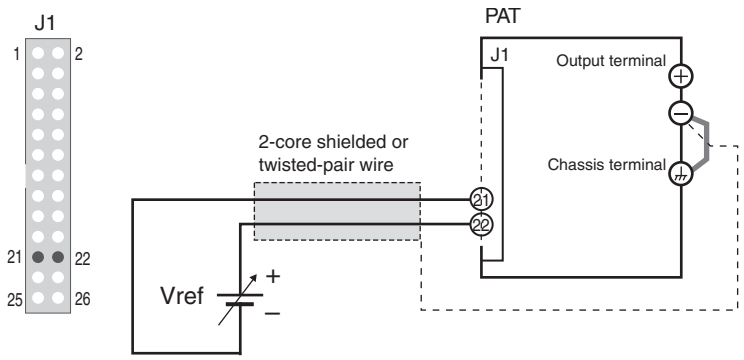


Fig.7-9 Connection for CAL.5

1 Turn the POWER switch off.

2 Connect the voltage source (Vref) to pins 21 and 22 of the J1 connector.

3 While holding down the SET switch, turn on the POWER switch.

Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.

4 Press the CONFIG switch.

The ammeter shows “CAL.5,” and the voltmeter shows “0.000.”

5 Set Vref to 0.000 V.

6 Press the RECALL A (SHIFT+SET) switch.

The calibration of the low end of the EXT CV CONT is set, and the LOCK LED illuminates.

7 Press the CONFIG switch.

The ammeter shows “CAL.5,” and the voltmeter shows “10.00.”

8 Set Vref to 10.00 V.

9 Press the RECALL A (SHIFT+SET) switch.

The calibration of the high end of the EXT CV CONT is set, and the EXT LED illuminates.

Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.

10 Turn the POWER switch off to finish the calibration of the output voltage control using external voltage.

Calibration procedure of the output voltage control using external resistance (CAL.6)

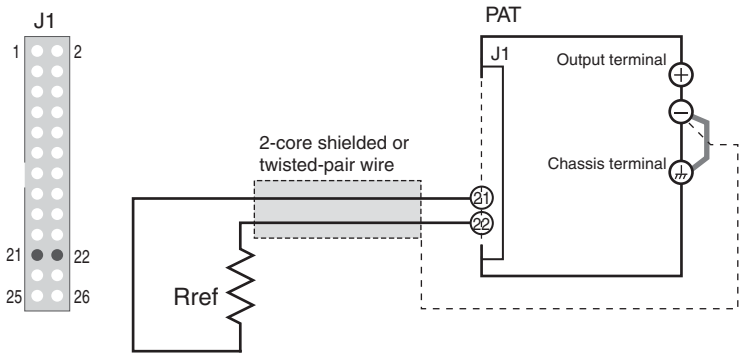


Fig.7-10 Connection for CAL.6

1. Turn the POWER switch off.
2. Connect the 0 Ω resistor (Rref) to pins 21 and 22 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the CONFIG switch.

   The ammeter shows “CAL.5,” and the voltmeter shows “0.000.”
5. Press the LOCK (SHIFT+LOCAL) switch.

   The ammeter shows “CAL.6,” and the voltmeter shows “0.000.”
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CV CONT resistor is set, and the LOCK LED illuminates.
7. Connect the 10 kΩ standard resistor (Rref) to pins 21 and 22 of the J1 connector.
8. Press the CONFIG switch.

   The ammeter shows “CAL.6,” and the voltmeter shows “10.00.”
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CV CONT resistor is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output voltage control using external resistance.

Calibration procedure of the output current control using external voltage (CAL.7)

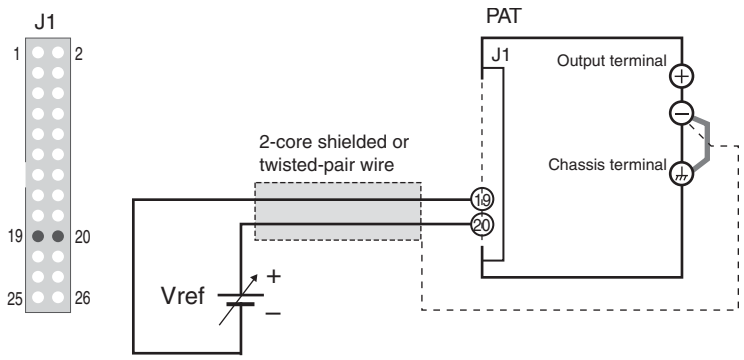


Fig.7-11 Connection for CAL.7

1. Turn the POWER switch off.
2. Connect the voltage source (Vref) to pins 19 and 20 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the STORE switch.

   The ammeter shows "CAL.7," and the voltmeter shows "0.000."
5. Set Vref to 0.000 V.
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CC CONT is set, and the LOCK LED illuminates.
7. Press the STORE switch.

   The ammeter shows "CAL.7," and the voltmeter shows "10.00."
8. Set Vref to 10.00 V.
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CC CONT is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output current control using external voltage.

Calibration procedure of the output current control using external resistance (CAL.8)

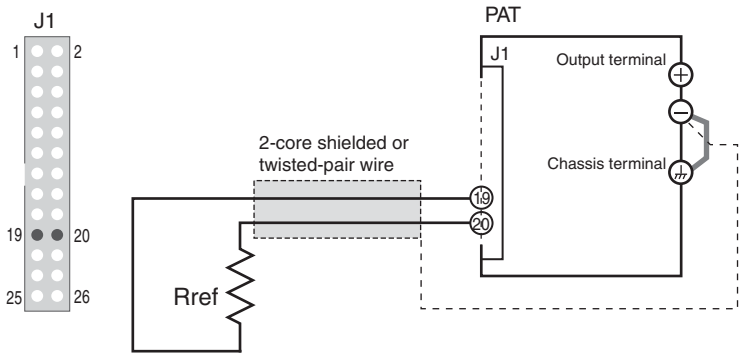


Fig.7-12 Connection for CAL.8

1. Turn the POWER switch off.
2. Connect the 0 Ω resistor (Rref) to pins 19 and 20 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the STORE switch.

   The ammeter shows “CAL.7,” and the voltmeter shows “0.000.”
5. Press the LOCK (SHIFT+LOCAL) switch.

   The ammeter shows “CAL.8,” and the voltmeter shows “0.000.”
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CC CONT resistor is set, and the LOCK LED illuminates.
7. Connect the 10 kΩ standard resistor (Rref) to pins 19 and 20 of the J1 connector.
8. Press the STORE switch.

   The ammeter shows “CAL.8,” and the voltmeter shows “10.00.”
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CC CONT resistor is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output current control using external resistance.

8

Specifications

This chapter describes the specifications, functions and gives the dimensions of the PAT.

Unless specified otherwise, the specifications are for the following settings and conditions.

- The load is a pure resistance.
- The warm-up time is 30 minutes (with current flowing).
- After warm-up is complete, the PAT must be calibrated correctly according to the procedures given in the operation manual in a 23 °C ± 5 °C environment.
- TYP (typical) values do not guarantee the performance.
- rtg:Indicates the rated output.
- rdng:Indicates the reading.
- Rated load and no load are defined as follows:

During constant voltage operation (set the output current at the rated voltage output greater than equal to the rated output current)

Rated load: Refers to a load with a resistance that makes the current that flows when the rated output voltage is applied to be 95 % to 100 % of the rated output current at the rated output voltage.

No load: Refers to a load through which no output current flows or an open output terminal condition with no load connected.

During constant current operation (set the output voltage at the rated output current greater than equal to the rated output voltage)

Rated load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 95 % to 100 % of the maximum output voltage at the rated output current. The output voltage of the PAT including the voltage drop in the load cable must not exceed the maximum output voltage at the rated output current.

No load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 10 % of the maximum output voltage or 1 V, whichever is greater, at the rated output current.

Model-specific specifications (Models rated output < 250 V)

AC input

		PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T
Nominal input rating	200 V input	200 V to 240 V, 50 Hz to 60 Hz, three-phase					
	400 V input	400 V, 50 Hz to 60 Hz, three-phase					
	Input voltage between U-G, V-G, and W-G*1	± 254 Vmax					
Input voltage range	200 V input	180 V to 250 V					
	400 V input	360 V to 440 V					
Input frequency range		47 Hz to 63 Hz					
Hold-up time for power interruption (MIN)	200 V input	20 ms or greater (at 50 % load), 10 ms or greater (at the rated load)					
	400 V input	20 ms or greater (at 50 % load), 5 ms or greater (at the rated load)					
Current (MAX)*2	200 V input	32.0 A					
	400 V input	18.0 A					
Inrush current (MAX) *3	200 V input	100 Apeak					
	400 V input	40 Apeak					
Wattage (MAX)*2		10 kVA					
Power factor (TYP)*4		0.95					
Efficiency (MIN)*5		85 %					

*1. At input terminals of the PAT.
*2. At the rated load.
*3. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).
*4. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.
*5. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.

Output

			PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T
Rating	Output power		8 kW					
	Output voltage		20.00 V	30.00 V	40.00 V	60.00 V	80.00 V	160.0 V
	Output current		400.0 A	266.0 A	200.0 A	133.0 A	100.0 A	50.0 A
Voltage	Preset range*1		0 % to 105 % of rtg					
	Setting accuracy*2		±(0.2 % of rtg + 50 mV)					
	Source effect*3		±(0.05 % of rtg + 5 mV)					
	Load effect*4		±(0.1 % of rtg + 5 mV)					
	Transient response*5		5 ms					
	Ripple noise	(p-p) *6	100 mV	300 mV	300 mV	350 mV		
		(rms) *7	10 mV	20 mV	30 mV	30 mV		
	Rise time (MAX)*8	Rated load	100 ms					
		No load	100 ms					
	Fall time (MAX)*9	Rated load	100 ms					
		No load	2000 ms					
	Temperature coefficient (MAX)*10		100 ppm/ °C (during external control)					
Current	Preset range *1		0 % to 105 % of rtg					
	Setting accuracy *2		±(0.5 % of rtg + 50 mA)					
	Source effect *3		±(0.1 % of rtg + 30 mA)					
	Load effect*4		±(0.2 % of rtg +30 mA)					
	Ripple noise	(rms) *7	500 mA	400 mA	400 mA	350 mA	300 mA	200 mA
	Temperature coefficient (TYP)*10		200 ppm/ °C (during external control)					

*1. The maximum preset voltage and current are used to determine constant voltage or constant current operation when the activation point of the constant voltage or constant current operation is set to the rated output voltage or current. It does not guarantee power supply to the load exceeding the rated output voltage or current.
To establish a constant voltage operation at the activation point (rated output voltage or current), set the output current (I Set) so that rated output current < I Set ≤ maximum preset current.
Likewise, to establish constant current operation, set the output voltage (V Set) so that rate output voltage < V Set ≤ maximum preset voltage.

*2. The difference between the actual output voltage or output current and the preset value under constant voltage or constant current operation.

*3. Output voltage or output current fluctuation with respect to ±10 % fluctuation of the nominal input voltage under constant voltage or current operation.

*4. Output voltage or output current fluctuation when the output voltage or output current is set to the rated output voltage or current and the load is changed from rated load to no load under constant voltage or current operation.

*5. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output current is changed from 100 % to 50 % or 50 % to 100 % of the rated output current under constant voltage operation. The output voltage when the output current is 100 % is used as a reference.
When the remote sensing function is used.

*6. When the measurement frequency bandwidth is 10 Hz to 20 MHz.

*7. Output voltage is 10 % to 100 % of the rating when the measurement frequency bandwidth is 5 Hz to 1 MHz.

*8. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.

*9. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.

*10. When the ambient temperature is within the range of 0 °C to 50 °C.

General specifications

			PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T
Weight (main unit only)		200 V input	Approx. 26 kg (57.32 lb)	Approx. 27 kg (59.52 lb)	Approx. 25 kg (55.12 lb)	Approx. 24 kg (52.91 lb)		
		400 V input	Approx. 27 kg (59.52 lb)	Approx. 27 kg (59.52 lb)	Approx. 25 kg (55.12 lb)	Approx. 24 kg (52.91 lb)		
Dimensions			See the outline drawing					
Environ-mental conditions	Operating conditions		Indoor use, Overvoltage Category II					
	Operating temperature		0 °C to +50 °C (32 ° F to +122 ° F)					
	Operating humidity		20 %rh to 85 %rh (no condensation)					
	Storage temperature		-25 °C to +70 °C (-13 ° F to +158 ° F)					
	Storage humidity		90 %rh or less (no condensation)					
	Altitude		Up to 2000 m					
Cooling system			Forced air cooling using a fan. (With fan control)					
Grounding polarity			Negative grounding or positive grounding possible.					
Isolation voltage			±250 Vmax					±500 Vmax
Withstand voltage	Across the input terminals and chassis							
		200 V input	No abnormalities at 1500 Vac for 1 minute.					
		400 V input	No abnormalities at 1500 Vac for 5 seconds.					
	Across the input terminals and the output terminals							
		200 V input	No abnormalities at 1500 Vac for 1 minute.					
		400 V input	No abnormalities at 1500 Vac for 5 seconds.					
	Across the output terminals and chassis		No abnormalities at 500 Vdc for 1 minute.					
Insulation resistance	Across the input terminals and chassis		500 Vdc, 30 MΩ or more. (at 70 %rh or less)					
	Across the input terminals and the output terminals							
	Across the output terminals and chassis							
Safety *1			Complies with the requirements of the following directives and standards Low Voltage Directive 2006/95/EC EN 61010-1, Class I, Pollution degree 2					
Electromagnetic Compatibility (EMC) *1, *2			Complies with the requirements of the following directives and standards. EMC Directive 2004/108/EC EN 61326-1 Applicable condition All of the cables and wires connected to the PAT are less than 3 m in length.					
Accesso-ries	OUTPUT terminal cover		2 sets (with screws)					
	Output terminal bolt set		2 sets (M12 × 25 mm bolts, nuts, and spring washers)		2 sets (M10 × 20 mm bolts, nuts, and spring washers)			
	J1/J2 connector kit		1 set (2 sets of protection covers, 2 plugs, and 30 pins)					
	Chassis connection wire		1 set (with screws)					
	User's manual		1 copy					
	CD-ROM *3		1 pc.					

*1. Not applicable to custom order models.
*2. Applies only to models that have CE marking on the panel.
*3. Contains the User's Manual, the Communication Interface Manual, and the KI-VISA.

Model-specific specifications (Models rated output ≥ 250 V)

AC input

		PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T
Nominal input rating	200 V input	200 V to 240 V, 50 Hz to 60 Hz, three-phase				
	400 V input	400 V, 50 Hz to 60 Hz, three-phase				
	Input voltage between U-G, V-G, and W-G*1	± 254 Vmax				
Input voltage range	200 V input	180 V to 250 V				
	400 V input	360 V to 440 V				
Input frequency range		47 Hz to 63 Hz				
Hold-up time for power interruption (MIN)	200 V input	20 ms or greater (at 50 % load), 10 ms or greater (at the rated load)				
	400 V input	20 ms or greater (at 50 % load), 5 ms or greater (at the rated load)				
Current (MAX)*2	200 V input	32.0 A				
	400 V input	18.0 A				
Inrush current (MAX) *3	200 V input	100 Apeak				
	400 V input	40 Apeak				
Wattage (MAX)*2		10 kVA				
Power factor (TYP)*4		0.95				
Efficiency (MIN)*5		85 %				

*1. At input terminals of the PAT.
*2. At the rated load.
*3. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).
*4. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.
*5. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.

Output

				PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T
Rating	Output power			8 kW				
	Output voltage			250.0 V	350.0 V	500.0 V	650.0 V	850.0 V
	Output current			32.00 A	22.80 A	16.00 A	12.30 A	9.40 A
Voltage	Preset range*1			0 % to 105 % of rtg				
	Setting accuracy*2			±(0.2 % of rtg + 50 mV)				
	Source effect*3			±(0.05 % of rtg + 5 mV)				
	Load effect*4			±(0.1 % of rtg + 5 mV)				
	Transient response*5			5 ms				
	Ripple noise	(p-p) *6	200 V input	450 mV	450 mV	600 mV	600 mV	600 mV
			400 V input	540 mV	540 mV	720 mV	720 mV	720 mV
		(rms) *7		50 mV	50 mV	100 mV	100 mV	100 mV
	Rise time (MAX)*8	Rated load		100 ms				
		No load		100 ms				
	Fall time (MAX)*9	Rated load		100 ms	200 ms			
		No load		2000 ms	4000 ms			
	Temperature coefficient (MAX)*10			100 ppm/ °C (during external control)				
Current	Preset range *1			0 % to 105 % of rtg				
	Setting accuracy *2			±(0.5 % of rtg + 50 mA)			±(1.0 % of rtg + 100 mA)	
	Source effect *3			±(0.1 % of rtg + 30 mA)				
	Load effect*4			±(0.2 % of rtg +30 mA)				
	Ripple noise	(rms) *7		200 mA	200 mA	200 mA	150 mA	120 mA
	Temperature coefficient (TYP)*10			200 ppm/ °C (during external control)				

*1. The maximum preset voltage and current are used to determine constant voltage or constant current operation when the activation point of the constant voltage or constant current operation is set to the rated output voltage or current. It does not guarantee power supply to the load exceeding the rated output voltage or current.
To establish a constant voltage operation at the activation point (rated output voltage or current), set the output current (I Set) so that rated output current < I Set ≤ maximum preset current.
Likewise, to establish constant current operation, set the output voltage (V Set) so that rate output voltage < V Set ≤ maximum preset voltage.

*2. The difference between the actual output voltage or output current and the preset value under constant voltage or constant current operation.

*3. Output voltage or output current fluctuation with respect to ±10 % fluctuation of the nominal input voltage under constant voltage or current operation.

*4. Output voltage or output current fluctuation when the output voltage or output current is set to the rated output voltage or current and the load is changed from rated load to no load under constant voltage or current operation.

*5. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output current is changed from 100 % to 50 % or 50 % to 100 % of the rated output current under constant voltage operation. The output voltage when the output current is 100 % is used as a reference.
When the remote sensing function is used.

*6. When the measurement frequency bandwidth is 10 Hz to 20 MHz.

*7. Output voltage is 10 % to 100 % of the rating when the measurement frequency bandwidth is 5 Hz to 1 MHz.

*8. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.

*9. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.

*10. When the ambient temperature is within the range of 0 °C to 50 °C.

General specifications

			PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T
Weight (main unit only)		200 V input	Approx. 23 kg (50.71 lb)			Approx. 22 kg (48.50 lb)	Approx. 23 kg (50.71 lb)
		400 V input	Approx. 23 kg (50.71 lb)	Approx. 24 kg (52.91 lb)		Approx. 22 kg (48.50 lb)	Approx. 24 kg (52.91 lb)
Dimensions			See the outline drawing				
Environmental conditions	Operating conditions		Indoor use, Overvoltage Category II				
	Operating temperature		0 °C to +50 °C (32 ° F to +122 ° F)				
	Operating humidity		20 %rh to 85 %rh (no condensation)				
	Storage temperature		-25 °C to +70 °C (-13 ° F to +158 ° F)				
	Storage humidity		90 %rh or less (no condensation)				
	Altitude		Up to 2000 m				
Cooling system			Forced air cooling using a fan. (With fan control)				
Grounding polarity			Negative grounding or positive grounding possible.				
Isolation voltage			±500 Vmax		±800 Vmax		±1000 Vmax
Withstand voltage	Across the input terminals and chassis	200 V input	No abnormalities at 1500 Vac for 1 minute.				
		400 V input	No abnormalities at 1500 Vac for 5 seconds.				
	Across the input terminals and the output terminals	200 V input	No abnormalities at 1500 Vac for 1 minute.				
		400 V input	No abnormalities at 1500 Vac for 5 seconds.				
	Across the output terminals and chassis		No abnormalities at 500 Vdc for 1 minute.		No abnormalities at 800 Vdc for 1 minute.		No abnormalities at 1000 Vdc for 1 minute.
Insulation resistance	Across the input terminals and chassis		500 Vdc, 30 MΩ or more. (at 70 %rh or less)		800 Vdc, 30 MΩ or more. (at 70 %rh or less)		1000 Vdc, 30 MΩ or more. (at 70 %rh or less)
	Across the input terminals and the output terminals						
	Across the output terminals and chassis						
Safety *1			Complies with the requirements of the following directives and standards Low Voltage Directive 2006/95/EC EN 61010-1, Class I, Pollution degree 2				
Electromagnetic Compatibility (EMC) *1, *2			Complies with the requirements of the following directives and standards. EMC Directive 2004/108/EC EN 61326-1 Applicable condition All of the cables and wires connected to the PAT are less than 3 m in length.				
Accessories	OUTPUT terminal cover		2 sets (with screws)				
	Output terminal bolt set		2 sets (M8 × 20 mm bolts, nuts, and spring washers)				
	J1/J2 connector kit		1 set (2 sets of protection covers, 2 plugs, and 30 pins)				
	Chassis connection wire		1 set (with screws)				
	User's manual		1 copy				
	CD-ROM*3		1 pc.				

*1. Not applicable to custom order models.
*2. Applies only to models that have CE marking on the panel.
*3. Contains the User's Manual, the Communication Interface Manual, and the KI-VISA.

Common specifications

Display function

Common specifications			
Voltmeter	Maximum display	Models rated below 100 V	99.99 (fixed decimal point)
		Models rated at 100 V or greater	999.9 (fixed decimal point)
	Display accuracy		±(0.2 % of rdng + 5 digits)
Ammeter	Maximum display	Models rated below 50.0 V	99.99 (fixed decimal point)
		Models rated at 50.0 V or greater	999.9 (fixed decimal point)
	Display accuracy		±(0.5 % of rdng + 5 digits)
Operation display	OUTPUT ON/OFF		ON: OUTPUT LED illuminates (Green LED). OFF: OUTPUT LED turns off.
	ALARM operation		ALARM LED illuminates (Red LED).*1 *2
	CV operation		CV LED illuminates (Green LED).
	CC operation		CC LED illuminates (Red LED).
	RMT operation		RMT LED illuminates during remote control (Green LED).
	EXT operation		EXT LED illuminates during external control (Green LED).
	LOCK operation		LOCK LED illuminates when the keys are locked (Green LED).

*1. Illuminates when the overvoltage protection (OVP), overcurrent protection (OCP), overheat protection (OHP), input open-phase protection (PHASE), fan failure protection (FAN), incorrect sensing connection protection (SENSE), overheat protection of the bleeder circuit (BOHP) and so on are activated.

*2. The ALARM LED illuminates for approximately 10 to 15 seconds if the breaker is set to trip when an SD signal is input or the OVP/OCP is activated or if the OHP activates on 400 V input models.

Protection functions

Common specifications		
Overvoltage protection (OVP)		Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1
	Selectable range	10 % to 111.5 % of the rated output voltage
	Setting accuracy	± 2 % of rtg
Overcurrent protection (OCP)		Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1
	Selectable range	10 % to 111.5 % of the rated output current
	Setting accuracy	± 3 % of rtg
Overheat protection (OHP)		Turns the output off (the breaker trips for 400 V input model). ALARM LED illuminates.
Input open-phase protection (PHASE)		Turns the output off. ALARM LED illuminates.
Fan failure protection (FAN)		Turns the output off. ALARM LED illuminates.
Incorrect sensing connection protection (SENSE)		Turns the output off. ALARM LED illuminates.
Overheat protection of the bleeder circuit (BOHP)		Turns the output off. ALARM LED illuminates.
Shut down (SD)		Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1

*1. The ALARM LED illuminates for approximately 10 to 15 seconds if the breaker is set to trip when an SD signal is input or the OVP/OCP is activated or if the OHP activates on 400 V input models.

Output signals

Common specifications			
Monitor signal output[*1]	VMON (Voltage)	At rated voltage output	10.00 V ± 0.25 V
		At 0 V output	0.00 V ± 0.25 V
	IMON (Current)	At rated current output	10.00 V ± 0.25 V
		At 0 A output	0.00 V ± 0.25 V
Status signal output [*1, *2]	OUTON STATUS		Turns on when the output is on.
	CV STATUS		Turns on during CV operation.
	CC STATUS		Turns on during CC operation.
	ALM STATUS		Turns on when an alarm (OVP, OCP, OHP, BOHP, input open-phase protection, fan failure protection, incorrect sensing connection protection, or shutdown) is detected.
	PWR OFF STATUS		Stays on for approximately 10 to 15 seconds after the POWER switch turns off.[*3]
	PWR ON STATUS		Turns on when the POWER switch is on.

*1. J1 connectors on the rear panel.
*2. Photocoupler open collector output, maximum voltage 30 V, maximum current (sink) 8 mA, insulated from the output and control circuits, and status signals are not mutually insulated.
*3. If the breaker is set to trip when an SD signal is input or the OVP/OCP is activated or if the OHP activates on 400 V input models.

Control functions

Common specifications		
External control[*1]	EXT-V CV CONT [*2 *3] (CV external voltage control)	0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.
	EXT-V (FAST) CV CONT [*2 *3] (CV external voltage control FAST)	0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.
	EXT-R CV CONT [*2] (CV external resistance control)	0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.
	EXT-R (FAIL SAFE) CV CONT [*2] (CV external resistance control FAIL SAFE)	100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.
	EXT-V CC CONT [*2 *3] (CC external voltage control)	0 % to 100 % of the rated output current in the range of 0 V to 10 V.
	EXT-V (FAST) CC CONT [*2 *3] (CC external voltage control FAST)	0 % to 100 % of the rated output current in the range of 0 V to 10 V.
	EXT-R CC CONT [*2] (CC external resistance control)	0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ.
	EXT-R (FAIL SAFE) CC CONT [*2] (CC external resistance control FAIL SAFE)	100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ.
	OUTPUT ON/OFF CONT[*4]	Output on with a low TTL level signal/output on with a high TTL level signal.
	SHUT DOWN[*5]	POWER switch off with a low TTL level signal.

*1. J1 connector on the rear panel.
*2. Set EXT-V, EXT-V (FAST), EXT-R, and EXT-R (FAIL SAFE) in the CONFIG settings. The selected function is enabled.
*3. The input impedance EXT-V CV CONT, EXT-V (FAST) CV CONT and EXT-V CC CONT, EXT-V (FAST) CC CONT is approximately 100 kΩ.
The setting accuracy is ±5 % of the rated output voltage or ±5 % of the maximum output current.
*4. Set the logic low/high using CONFIG settings.
*5. The output turns off even if the breaker trip setting of the CONFIG parameter is set so that the POWER switch does not turn off.

Interface

Common specifications		
Common specifications	Soft ware protocol	IEEE Std 488.2-1992
	Command language	Complies with the SCPI Specification 1999.0 specifications.
RS232C	Hardware	Complies with EIA232D.
		D-SUB 9-pin connector (male) *1
		Baud rate: 1200, 2400, 4800, 9600, 19200, and 38400 bps
		Data length: 7 bits or 8 bits. Stop bit: 1 bit or 2 bits. No parity. Flow control X-Flow or none.
	Program message terminator	LF during reception, CR/LF during transmission.
GPIB*2	Hardware	Complies with IEEE Std 488.1-1987.
		SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, and E1.
		24 pin connector (receptacle)
	Program message terminator	LF or EOI during reception, LF+EOI during transmission.
	Primary address	1 to 30
USB*2	Hardware	Complies with USB 2.0. Data rate: 12 Mbps (full speed).
		Socket B type
	Program message terminator	LF or EOM during reception, LF+EOM during transmission.
	Device class	Complies with the USBTMC-USB488 device class specifications.
LAN*2	Hardware	IEEE 802.3 100Base-TX/10Base-T Ethernet Complies with the LXI Class C, Specification 1.2.
		IPv4, RJ-45 connector *3
	Communications protocol	VXI-11
	Program message terminator	LF or END during reception, LF+END during transmission.

*1. Use a cross cable (null modem cable).
*2. Factory option.
*3. Category 5, use a straight cable.

Other functions

- Master-Slave parallel operation
- Output status setting at power-on setting
- Output on / off delay setting
- Preset memory
- Lock
- Fine adjustment
- Voltage / current setting limit
- Communication error display

Dimensions

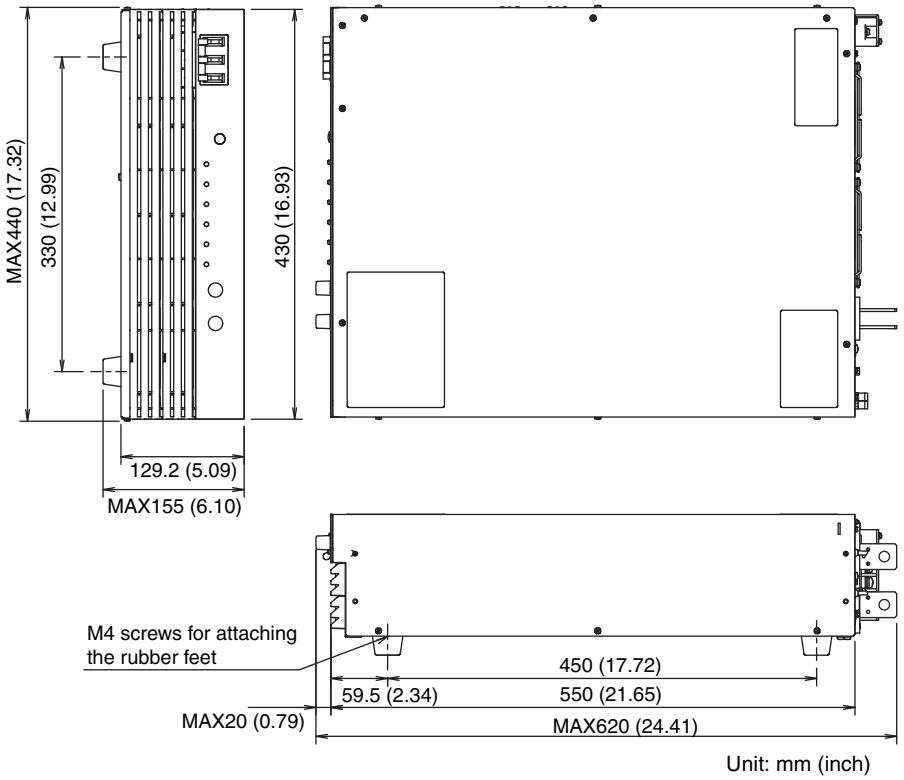


Fig.8-1 PAT-T series outline drawing

Appendix

The appendix contains options and troubleshooting.

A.1 Options

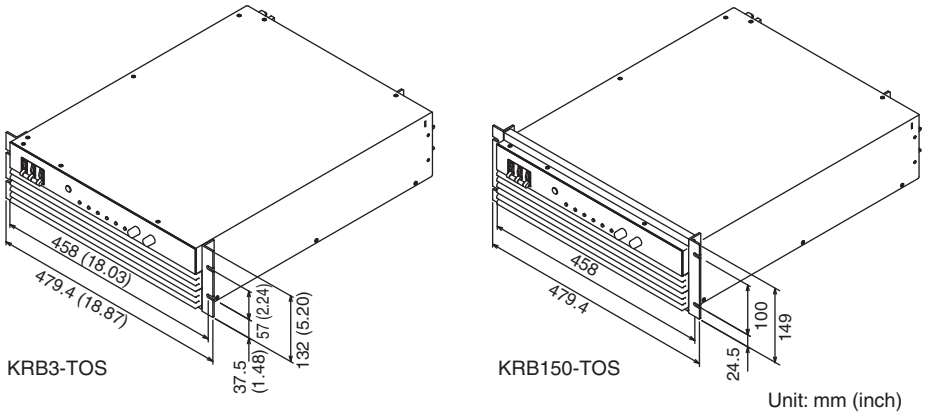
The options listed below are available for the PAT-T Series.

For details on the options, contact your Kikusui agent or distributor.

See p. 1-3

■ Rack mounting option

Product	Model	Note
Rack mount bracket	KRB3-TOS	Inch rack EIA standard
	KRB150-TOS	Milli rack JIS standard

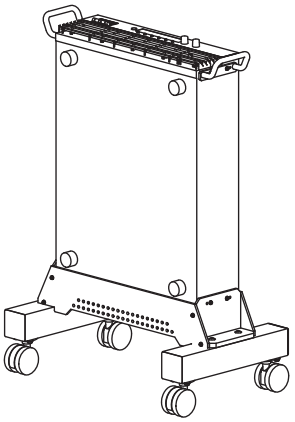


Unit: mm (inch)

■ Vertical stand

A vertical stand is used as a stand to hold the equiment in a vertical position.

Product	Model	Note
Vertical stand	VS01	580 W x 245 H x 350 Dmm(MAX) (Excluding the size of the equipment)

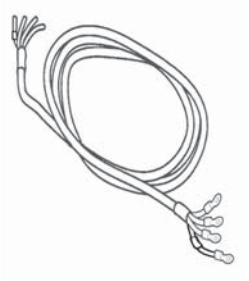


See p. 1-4

■ Power cable

A power cable to connect to the input terminal block on the rear panel.

Product	Model	Note
Power cable	AC8-4P4M-M6C	4 m 4 cores

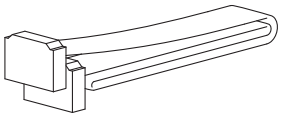


See p. 5-4

■ Cable for parallel operation

A cable used when performing parallel operation.

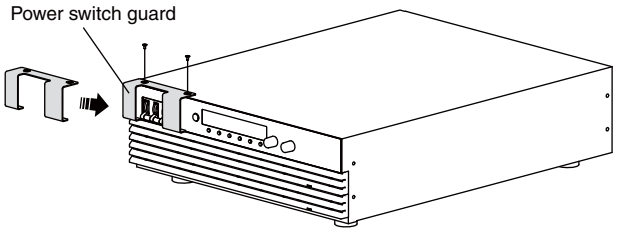
Product	Model	Note
Cable for parallel operation	PC01-PAT	250 mm 26 pins



■ Power switch guard

A power switch guard is to prevent accidental operation of the POWER switch.

Product	Model	Note
Power switch guard	OP01-PAT	–



A.2 Troubleshooting

This section introduces troubleshooting measures. Typical symptoms are listed. Check whether any of the items below apply to your case. In some cases, the problem can be solved quite easily.

See p. 3-28

If none of the items apply to your case, we recommend that you initialize the PAT to factory default settings. If the remedy does not correct the problem, contact your Kikusui agent or distributor.

The power does not turn on.

Symptom	Check Items	Remedy	See
The PAT does not operate when the POWER switch is turned on.	Is the power cable is broken?	Replace the power cable with a new one.	1-4
	Is the wiring to the U, V, W, and GND of the AC INPUT terminal correct?	Connect the cable correctly.	1-4
On the 400 V input model, when the POWER switch is turned on, it is turned off again immediately.	Are you turn the POWER switch on and off at an interval of 40 s or less?	After you turn the POWER switch off, wait for at least 40 s before you turn it back on.	1-7
	Is the input voltage too high (above 440 Vac)?	If you experience this problem even when the input voltage is within the specified input voltage range, the PAT may be broken. Contact your Kikusui agent or distributor.	8-2
	Is the overheat protection (OHP) feature activated?	The internal temperature is abnormally high. Check the operating conditions. After you have removed the cause of the abnormal temperature, turn the power switch on.	iii 3-12
		The dust filter may be clogged, or the fan may be broken. Check them.	7-2
When the POWER switch is turned on, the OVP is activated, and the POWER switch is turned off.	Use external control to turn the output off (short pins 13 and 14 on the J1 connector), and then turn the POWER switch on. Afterwards, check the following: 1. Is the output status setting at power-on set to on (CF25: ON)? 2. Is the breaker trip setting when the OVP or OCP is activated set to trip (CF28: ON)? 3. Is the OVP trip point set to a voltage that is below the output voltage?	If the answers to questions 1, 2, and 3 are yes, when you turn the POWER switch on, the OVP will be activated, and the POWER switch will be turned back off again. Either change the OVP trip point, or reset the PAT to its factory default settings.	3-3

No output is delivered.

Symptom	Check Items		Remedy	See
No output is confirmed even when the OUTPUT switch is turned on.	Is the output voltage set to 0 V, and the output current set to 0 A?		Turn the knobs to set the output voltage and output current to the required values.	3-7
	Are you performing output on/off control using an external contact?	Yes	Turn the output on using the external contact.	4-17
		No	Set the external control logic setting of the output on/off to “turn the output on with a high signal” (CF22: H).	3-18

Unable to set the output voltage or output current.

Symptom	Check Items	Remedy	See
Unable to set the output voltage.	Are you trying to set a voltage higher than the OVP trip point?	Change the OVP trip point or disable the voltage limit setting (CF29: OFF).	3-19
Unable to set the output current.	Are you trying to set a current higher than the OCP trip point?	Change the OCP trip point or disable the current setting limit (CF30: OFF)	3-19

The output is unstable.

Symptom	Check Items	Remedy	See
Some output levels are unstable when I turn the VOLTAGE or CURRENT knob while the output is on.	Is the operation mode switching from CV to CC or CC to CV?	Change the setting (output voltage or output current) that is limiting the output to a value greater than the present setting. If the preset value is at maximum, you must use a power supply with a larger output voltage or current.	3-5 3-7
The output voltage or output current fluctuates.	Are you using master-slave parallel operation?	The performance degrades slightly during master-slave parallel operation.	–
	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch on the rear panel.	3-25
	Are both the CV LED and the CC LED turned on?	• If the output is oscillating when using remote sensing, insert a capacitor across the load. • The circuitry may have malfunctioned. Immediately stop the use of the PAT and request repairs.	3-25
	Does the sensing cable or load cable have poor contact or is the cable broken?	Turn off the POWER switch and check the wiring.	1-4
	Does the load current have peaks or is it pulse-shaped?	The peak value may be exceeding the preset current. Increase the preset current or increase the current capacity.	3-7
The output voltage is offset from the value at power-on.	Did 30 minutes pass since the power was turned on?	Warm up the PAT with the power turned on for at least 30 minutes.	–

The output ripple is large.

Symptom	Check Items	Remedy	See
The ripple sometimes becomes large.	Is the input voltage outside the range?	Supply a voltage that is within the input voltage range.	8-2
The ripple increased when the installation location was changed.	Is there a source of strong magnetic or electrical field nearby?	Take measures such as moving the PAT away from generating sources and twisting cables.	–
The output ripple is large when using external control.	Is the noise on the external voltage large?	Take measures against noise.	–
The ripple increased when the load cable was changed.	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch on the rear panel.	3-25

The ALARM indicator illuminates when the OUTPUT switch is turned on.

Symptom	Check Items	Remedy	See
The ALARM LED illuminates when the OUTPUT switch is turned on.	Is the OVP trip point set less than or equal to the output voltage?	Set the OVP trip point to a voltage greater than or equal to the output voltage.	3-9
	Is the OCP trip point set less than or equal to the output current?	Set the OCP trip point to a current greater than or equal to the output current.	3-9
	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch.	3-25
	Is the polarity of remote sensing cable connection reversed?	The polarity of the remote sensing cable may be reversed, or the ends may be shorted. Check the load cable.	3-25
	Are you using remote sensing with a long load cable?	Set up the environment so that the voltage drop in the load cable is within the compensation voltage range (0.6 V for a single line).	3-25
	Is the control cable loose in the external control?	Connect it correctly.	Chap 4
	Is the external voltage excessive in the external control?	Apply the correct voltage.	4-9 4-13
	Is one of the phases of the three-phase input open?	The distribution system is abnormal or one of the phases of the three-phase input is open. Check the distribution system and the three-phase input cable, and connect the PAT to an AC power supply that matches with the specifications of the PAT.	1-4
	Is the internal temperature is abnormally high?	The overheat protection function is activated. Check the operating environment.	iii 3-12
		The dust filter may be clogged, or the fan may be broken. Check them.	7-2
The ALARM LED illuminates when the load is changed.	Is a large external voltage applied such as with a battery load?	• The overvoltage protection function or the overcurrent protection function may be activated. Check them. • The PAT may be overloaded. Check the load.	3-5
	Is the actual output voltage is higher than the preset voltage shown on the panel?		
	Is a special load is connected?		

Unable to operate the panel switch.

Symptom	Check Items	Remedy	See
Unable to operate the panel switch.	Is the LOCK LED illuminated?	Release the panel operation lock.	3-24
	Is the REMOTE LED illuminated?	To control the PAT from the panel, press the LOCAL switch to enable local mode	3-25
	Is the PAT being controlled via the RS232C, GPIB, USB or LAN interface?		
The PAT does not switch to local mode even when I press the LOCAL switch.	Was a local lockout (llo) specified to the communication interface?	Use a communication command to clear the local lockout (llo).	3-25

Index

Numerics

400 V input model -iv, 1-5, A-4

A

AC INPUT 1-5
accessories 1-2
alarm 3-8
  cause display 3-16
  release 3-9

B

BOHP 3-12
breaker trip 4-19
Breaker trip setting
  when the OVP or OCP is activated 3-19
  when the shutdown signal is applied 3-19

C

calibration 7-5
CC control source setting 3-17
CC mode 3-5
CD-ROM contents 6-9
Communication error display setting 3-17
CONFIG settings 3-14
Constant Current Power Supplies 3-5
Constant Voltage Power Supplies 3-5
Crossover point 3-6
CV control source setting 3-17
CV mode 3-5

D

Dimensions 8-11
dust filter 7-2

E

External Control
  Output Current 4-13
  Output On/Off 4-17
  Output Voltage 4-9
  Shutdown Control 4-19
External Monitoring 4-21

F

Factory default settings 3-28
Fan failure protection 3-12
Fine adjustment function 3-7
Firmware version 1-6
firmware version 1-2

G

GPIB interface 6-5
grounding 1-6

I

IEEE 488.2 6-2
Incorrect sensing connection protection 3-13
Input open-phase protection 3-13
inspection 7-2
isolation voltage 2-4

J

J1 connector 4-2

L

LAN interface 6-7
limit setting 3-10
  setting 3-19
Load 2-2
load cable 2-4
  current capacity 2-4
LOCK function 3-24
  Preset recall setting while locked 3-17

M

master 5-2
master unit 5-2
Master-Slave Parallel Operation 5-2
  Connection 5-4
  setting 3-18
  Setting the number of units 3-18
Measured value display 3-2

O

OCP 3-9
OHP 3-12
options 6-5, 6-6, 6-7, A-2
OUTPUT
  OFF DELAY setting 3-16
  ON DELAY setting 3-16
Output 3-18
  External control logic setting of the output on/off 3-18
  on startup state setting 3-19
  on/off delay functions 3-4
  Output on/off when power is turned on 3-3
  terminal grounding 4-5
Output status setting at power-on 3-18
Output Terminal
  connection 2-6
Output Terminal Insulation 4-5
overcurrent protection 3-9
overheat protection (OHP) 3-12
overheat protection of the bleeder circuit (BOHP) 3-12
overvoltage protection 3-9
OVP 3-9

P

Parallel Operation 5-2
  Connection 5-4
POWER 1-6
power cable 1-4
power, turning on 1-6
preset memory function 3-23

R

Remote Control
  Default Conditions A-4
Remote interface setting 3-21
remote sensing 3-25
  status display 3-16
RS232C interface 6-3
  protocol 6-4

S

SCPI 6-2
sensing
  switch 3-27
  terminal 3-27
Series Operation 5-9
  Load Connection 5-11
Setting display 3-2
Setting limit 3-10
Setting the Output Current 3-7
Setting the Output Voltage 3-7
Shutdown 3-13
slave unit 5-2
slaves 5-2
specifications 8-2
Status signal setting of the output on/off 3-18
Switching from Remote to Local Mode 3-25

T

Troubleshooting A-4

U

USB interface 6-6

V

version 1-2
VISA drivers 6-10